THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 27. Thursday, February 22nd, 1923. No. 340.

PUBLISHED WEEKLY.

Subscriptions Terms: 15s per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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Foundry Research.

Whilst no national research organisation exists for the steel trade, no industry is better equipped for industrial investigation. In Sheffield alone there are probably 100 chemical laboratories. It would be of interest for foundrymen to examine the conditions which have brought about this desirable state of affairs and to ascertain if they are applicable to the cast-iron industry, and further, if considered of advantage, to utilise them similarly. Basically, steel is simple alloy of iron and carbon, and research work done on practically pure materials has a definite practical bearing. The bulk of the useful research work of two decades ago consisted of preparing commercially pure steel and adding to it increasing percentages of an extra element.

This was the natural method of research, and most workers followed it. Obviously, their results were comparable, and definite progress was shown. When cast iron is the subject of research totally different conditions exist as the commercial alloys have but small relationship to the pure iron-carbon alloy. Some metallurgists envisage cast iron as a ternary alloy of iron carbon and silicon, but it is open to question whether even this fulfils requirements. Some go even farther and complicate matters by regarding the alloy as a quarternary one of iron-carbon-silicon-phosphorus. It is thus apparent that an almost indefinite number of modifications are possible which would require many years of research work to cover, confirm and place before the foundry world as undeniable fact. Referring once again to steel, we would emphasise that the bulk of the research is comparable because there exists the unwritten law, that the *basic alloy is a pure iron-carbon one.* Unfortunately this does not apply to cast iron, and we consider it is now essential that a similar unwritten law be established for cast iron. The first phase of the unwritten law to be propounded is the uselessness of trying to embrace every square foot of the whole field. Certain alloys must be left for independent workers, as not being of general interest. With this first phase is associated the question of the choice of some basic alloys to represent the major portion of the field covered. It has been indirectly suggested that three alloys would be sufficient. However, the fewer that could be established as covering the widest field, the better.

The three alloys which have been chosen by one worker are hard cylinder, ordinary cylinder and ordinary grey irons. We suggest that this or a similar classification should be adopted as a base for fundamental research. A set of conditions should be established which the research worker can consider as normal. For instance, the temperature of the metal and the mould. From these basic conditions variables would be introduced, first the physical ones and then composition. Even on this basis it will be apparent that the use of three alloys as a basis would involve perhaps twice as much work as when experimenting with steel, which has pure iron and carbon as its base. For several decades, metallurgists have presented papers on the influence of this or that element on steel. In the future we hope papers will be presented on the influence of some element on hard cylinder iron, or the influence of teeming speeds on the solidity of ordinary grey iron. In practice every foundryman realises the profound difference between a window sash and an automobile cylinder, but for the purposes of research there is only cast iron. We sincerely believe that by dividing cast iron into three sections research would not be complicated but simplified. Cast iron, considered as a whole, is a paradise for the academical research worker and a paradox for the technical man.

I.B.F. Notes.

The Executive Committee of the Institution of British Foundrymen, sitting in Manchester last Saturday, recommended that June 13, 14, and 15 should be the period covered by the annual conference, and that Manchester should be the venue.

Members of the Institution of British Foundrymen will be pleased to learn that the Scottish Branch have appointed Mr. H. Winterton as their delegate to the General Council.

Private Technical Lectures.

The British Non-Ferrous Metals Research Association has decided upon the communicating of the results of its research investigations to its members by lectures which are to be arranged at one or more centres and to which, as a rule, only the members of the Association itself are admitted. Two objects are served in this manner; firstly, early confidential communication of the results of the research is assured to those who have given it financial support, and, secondly, the investigator gets into close and immediate contact with that section of the industry chiefly interested in his work.

In this manner the future direction of work and the relative practical importance of its varied issues is subjected to the mutual consideration of researcher and the industry.

The Non-Ferrous Metals Research Association is at present engaged on some ten investigations, all of which are closely connected with different branches of the metals and engineering trades.

So far the private lecture system has been applied to two subjects. Dr. W. Rosenhain, F.R.S., has reported on the investigation on copper, and the influence upon its properties of small quantities of impurities, which is being carried out for the Association by Dr. D. Hanson and others at the National Physical Laboratory. This research promises to be of fundamental importance to the copper and brass industry, and most of the leading firms are supporting the work and eagerly take advantage of opportunities, such as this lecture afforded, of hearing the results achieved.

Another large attendance of members was occasioned by the lecture on "The Cause and Prevention of Red Stains on Brass," by Mr. E. A. Bolton, M.Sc., describing work on this troublesome difficulty which he is carrying out at the Birmingham University—another subject of great practical interest.

The Association has now arranged a third lecture to be given both in Birmingham and Sheffield by Mr. Dartrey Lewis, M.Met., on his work on "Materials Used for the Abrasion and Polishing of Metals." In view of the wide interests covered, a limited number of tickets is being issued to non-members. The Birmingham lecture will be held on February 26, at 7.30 p.m., and the Sheffield lecture on February 23, at 2.30 p.m., and tickets, so far as space permits, can be obtained on written application by firms to the Association's offices, 71, Temple Row, Birmingham.

The British Science Guild.

This Association differs materially from most other technical organisations inasmuch as no qualifications are required. The object of the Guild is to provide a common platform, upon which all who desire to use scientific methods in the work for national prosperity may meet on an equal footing and without the suspicion of self-interest.

Amongst the methods they employ is the awarding of a prize of a similar nature to the Nobel, the formation of provincial branches, and the appointing of committees to study any branch of science requiring it. They are now appealing for funds to promote these objects. Particulars of the appeal may be had on application to the Appeal Director at 6, John Street, Adelphi, London, W.C.2.

Pipes for South Africa.—His Majesty's Senior Trade Commissioner in South Africa reports that tenders are invited by the Municipality of Kimberley for the supply of steel or cast-iron water pipes, valves and specials. The pipes range from 1¼ in. to 14 in. dia., and the specials and fittings comprise angle and square crosses, square tees, spindle and wheel valves, bends, elbows, etc. Tenders, on the proper form, must reach the Town Clerk of the Municipality of Kimberley not later than noon on March 22. A copy of the general conditions, specification, schedule and of the form of tender are available for inspection at the Department of Overseas Trade (Room 47), 35, Old Queen Street, London, S.W.1.

Book Reviews.

STRUCTURAL DESIGN IN THEORY AND PRACTICE. By Henry Adams.—London: Constable & Company, 10-12 Orange Street W.C.2. (Price 10s. 6d. net.)

This is the second edition of Professor Adams's "Theory and Practice of Designing," published some years ago. It deals with the theory of structures (in timber, brickwork, stone, concrete, cast iron, steel, etc.) from the most elementary examples to those somewhat more involved. The arrangement is progressive to suit a beginner's requirements, and only simple problems in mathematics are introduced; graphic methods are employed wherever possible. A new chapter has been added on reinforced concrete work. In the chapter on Cast-Iron Cantilevers and Girders we are told that cantilevers are very often improperly fixed because the principles involved are not properly understood, and it is more by good luck than management that failures do not more often occur. Professor Adams thoroughly understands and very lucidly explains the principles, but if the particular cantilever selected by him as a numerical example is put up as designed by him it will probably require the prayers of the faithful to keep it up when fully loaded. The first design got out (Fig. 206) would have meant a maximum pressure of 61.2 tons per sq. ft. on the front stone template, which the Professor rightly considers excessive. So he has widened considerably the wall-hold of the cantilever, but even then the maximum pressure would be still very high (34 tons per sq. ft.) for York stone, but may, in his opinion, be permissible with selected material of good thickness. The selected material would of course not be York stone, because elsewhere we are told by the author himself that the safe load on York stone is only 12 tons (page 142) or 15 tons (page 150) per sq. ft.

Publications Received.

THE METROPOLITAN VICKERS ELECTRICAL COMPANY, LIMITED.—Brochures entitled "Electrolytic Lightning Arresters" and "High Voltage Switch-gear Design." The former is reprinted from the "Metropolitan Vickers Gazette" and the latter from the "Electrician." Both are by Mr. W. A. Coates. "Steam Turbines" is the title of a third publication. It is a beautifully produced work of some 88 pages, and contains a fund of information as to the design and efficiency of the Metropolitan Vickers Rateau-impulse type machine.

Deaths.

MR. JOHN C. LUPTON, of Lupton Bros., Limited, Grange Works, Accrington, died on February 4, aged 72.

MR. D. Y. CASSELS, of Potts, Cassels & Williamson, engineers, Motherwell, and at one time a director of the Steel Company of Scotland, Limited, and the Dalmellington Iron Company, Limited, died recently, in his 64th year.

MR. W. H. REDDAN died at his residence, Thurgarton Priory, near Mansfield, recently. He was a county magistrate and managing director of the firm of Barringer, Wallis & Manners, Limited, tin-box makers, Rock Valley, Mansfield

MESSRS. BEECROFT & PARTNERS, LIMITED, of St. Peter's Close, Sheffield, have recently placed upon the market a ladle flux, which they claim causes the slag inclusion to rise to the surface, and lengthens considerably the life of the ladle linings.

MR. T. L. GREENWOOD, formerly secretary to Thos. W. Ward & Company, Limited, Albion Works, Sheffield, who died on December 15 last, left estate of the gross value of £1,543, of which £1,361 is net personalty.

THE VISCO ENGINEERING COMPANY, LIMITED, 82, Victoria Street, London, S.W.1, have appointed the following additional representatives: Mr. N. A. Lane, 21, Bennetts Hill, Birmingham, for the Birmingham district; Mr. L. M. Russell Cox, Arrad House, Whitehall Road, Rugby, for the South Midlands district; Mr. Wm. Wilde, West Carr Lane, Stoneferry, Hull, for the Hull district, and Mr. A. C. Scott, 102, St. Mary Street, Cardiff, for the South Wales district.

Test-Bars.

By a Member of the Institution of British Foundrymen.

Definition.

The expression "test-bars" is, in the foundry world, interpreted as castings of certain specified sizes to be poured from the same materials as the castings they represent. At present there are no definite sizes or methods of casting test-bars. Some inspecting engineers insist on the bars being cast on the castings, others are not so particular, and will accept bars, if cast from the same material; some specify one size, and for the same job others want quite a different size of bars, and very often, if a specification asks for certain size of bars to be cast on the castings, the inspector will insist on this, to the detriment of the castings, by which it will be understood that the inspector gets a good test-bar and an inferior casting.

It is not proposed in this article to deal with a long series of tests and figures for castings, but to give a general idea of the tests; also, for the sake of simplicity, to leave out all analyses.

For steel castings there is generally a tensile test; for grey iron, tensile, and transverse with deflection; for malleable, tensile and bend; and for non-ferrous castings, generally, tensile tests, with elongation specified.

Utility.

That test-bars for castings in steel, iron or non-ferrous work are necessary in many cases every foundryman will agree, but as to whether, as made under present methods, they are representative of such work, is open to question.

The tests for grey iron seem to be open to argument more so than those of steel or non-ferrous practice. There can be no doubt that all test-bars should be made by the same methods and materials, and also present the same thermal history as the castings, to be representative of such castings. This is imperative. No engineer will accept tests from forgings or steel work of any kind unless the test-piece has been through the same treament as the particular job it represents. This applies in a less degree to all castings.

From the previous remarks, it will be seen that for a test-bar to be as near representative of castings as foundry conditions permit, there should be no chilling or densening resorted to. This is a common practice in non-ferrous work, especially with manganese bronze and gun-metal. Chilling or densening of cast test-bars has the effect of hastening the cooling, with the result that they do not go through the same range of cooling at the same speed as the castings. This quicker cooling (under-cooling) of test-bars gives an entirely different structure from that in the casting, more pronounced in cast iron than other materials.

Therefore all test-bars should be of a size somewhat proportionate to the mass of the casting. Under-cooling non-ferrous test-bars very often raises the tensile and changes the elongation. With grey iron this causes many changes. A high-Si iron, under-cooled, will give a higher tensile and higher transverse load with less deflection, and, as the Si is reduced, the tensile and transverse tests will increase to a point at which, when the Si is sufficiently low or the under-cooling effect sufficiently strong to raise the C.C. above a certain point, the test-bars will be useless, giving poor results in the transverse, and perhaps being too hard to turn for tensile test.

It is not proposed to give any figure for the C.C. content at which this is likely to apply, as there are the other constituents in cast iron which have the same effect, and the whole question of the quantity of C.C. is interdependent—it may be higher or lower as the case may be.

Can Test Bars be made Representative of Castings?

With reference to cast-iron bars, the American opinion is that a test-bar can never in any case be other than only representative of the material used in the castings, and no criterion of the structure of the articles. Many foundrymen in this country are of similar opinion, whereas a large number state definitely that test-bars can be made, and should be made, as some guide to the strength, structure, etc., of the castings, and unless this latter condition is aimed at, of what utility can test-bars be to the engineer?

Test-bars for all castings, steel, iron or non-ferrous, can only be comparative, and never under foundry conditions give the actual strength of the casting. The different sizes, sections, rate of pouring, strains, etc., which are, many of them, unavoidable, all give rise to conditions which do not apply to the test-bars, and under no conditions should these circumstances be aggravated by further "faking" the test-bars. One should endeavour in all cases to make the tests as relative to the castings as possible. The statement made by the Americans that the test-bar cannot represent the castings, but only the materials in the castings, is true up to a point. It is more complicated from the cast-iron point of view than steel or brass. As an instance, leaving out the tensile load and using elongation for an argument. A casting made from a material which has a certain percentage of elongation will certainly have some elongation in it, perhaps more or less as the structure alters from light to heavy, but on the aggregate it will have some relation to the elongation in the test-bars. Therefore this class of bar has certain definite relations to the class of castings it represents, as both have elongation in them.

Leaving out "hair-splitting" figures, and endeavouring to give reasoning as plain as experience permits, but declining to be questioned as to the theory of the amount of elongation in cast iron, the author does not know that he feels sure there is any, but it does not mean anything to foundrymen at present. What one has to aim at with the production of cast iron is to obtain as strong a structure as possible under foundry conditions.

To return to the test-bar not representing the casting, a cast-iron test-bar always represents the castings in relation to the elongation, as neither castings nor bars, as previously stated, have any elongation to argue about other than academically. This shows that castings and bars in this particular material cannot be altered under grey-iron foundry conditions, because there is no elongation worth considering. On the other hand, the steel and non-ferrous castings, having elongation in them, will still have this feature under normal foundry conditions. Therefore it is safe to state that in this feature "elongation" bars are, to a point, representative of castings.

It is not proposed to use the steel or non-ferrous test for further argument, as the author does not feel that there are the complications arising from them as cast-iron test-bars. The under-cooling effects on the former materials, in castings are not so serious or pronounced as in grey cast iron. Every engineer or foundryman is only too well acquainted with the chilled or hard castings which are met with in every foundry, and which cannot, under the most up-to-date and scientific foundry practice, always be avoided, and under cupola melting conditions, that the results are so good is a credit to those who have to use such erratic melting equipment. There is a very narrow limit between soft castings and those too hard for successful machining, especially so in castings which have to withstand water test and also have good machining properties.

Cause of Hard Castings.

The chief cause of hard castings in grey iron is again the result of under-cooling, and the hard casting, if it had gone through the normal range of cooling, would, under ordinary foundry conditions, be soft. This under-cooling may be the result of the analysis of the iron not being suitable for the job, or some chilling effect in the mould, or wrong casting temperature. This shows that it is a complicated business making grey-iron castings with, in the first instance, materials which cannot be brought to a guaranteed analysis; secondly, melted as a rule in cupolas, which give erratic results, and then if used in dry, green or wet moulds and wrong pouring temperatures, will give all kinds of results.

C

This is the problem foundrymen have to face and overcome, and the question of the test-bars under these conditions presents difficulties. Here, again, the result of obtaining tests relative to the castings depends on their thermal history, both in regard to analyses and mass.

Graphitisation.

The whole of grey iron and malleable foundry practice is based on "graphitisation"—that is, the change from the C.C. (cementite or metastable form of C.) to the more stable form of graphite, and unless this is successfully carried out in accordance with such foundry practice, the results are disastrous. For malleable, low-Si irons are used, which give a white-iron casting. This, again, is owing to the low Si bringing about an under-cooling effect, with the result that the C. is nearly all in the combined form. To make the castings machineable, they are annealed at a temperature and time that changes the C.C. to the stable form of graphite somewhat different in form from that in grey-iron castings, and which difference need not enter into the present discussion. As previously mentioned, one can obtain this under-cooling effect either by reducing the Si or altering the other elements, or shortening the time of cooling or lowering the temperature at which the casting is poured, which is equal again to shortening the cooling range, as it is evident that a mould poured on the stiff side will set sooner than one poured very hot. As an example of this temperature and time effect, the author has cast a number of sections of irons all in the same mould on the same runner, as will be seen from Fig. 1. These pieces range from $1\frac{3}{4}$ in. thick to $\frac{3}{8}$ in. thick, and are from a low-Si iron, as used in heavy cylinder castings which have to withstand hydraulic tests, and have a good hard-wearing surface. It will be seen that the fractures range from grey in the $1\frac{3}{4}$ in., mottled in the 1 in., and white in the two thin bars. This is clear evidence of the under-cooling effect in grey iron, brought about by the reduction of thickness or mass, and this effect follows in a less degree throughout all grey-iron castings—that is, where there is any change in sections or rate of cooling, effective graphitisation has not had the temperature and time to take place. This illustration, simple as it is, should show the difficulties under which grey-iron foundry practice is carried out, also the narrow margin between success and failure; that is, that hard and soft castings can be easily obtained from the same material; also that castings should be as nearly even in sections as circumstances permit, as it is evident the foundry cannot use several classes of iron in the same casting, nor is it feasible in most cases to apply denseners to achieve the object of even cooling.

The foundry has to resort to the easiest method of governing the rate of cooling or the control of the C. by altering the Si content of the iron. That S, Mn, P have somewhat similar effects in certain cases may be, but it is, though, preferable to leave out these elements, to simplify what is a sufficiently contentious question without them.

Size and Number of Test Bars Necessary.

The question of the size and number of the test-bars for grey-iron castings should be in relation to the castings. American opinion, which is fairly strong, has adopted one size of bar with varying loads for all classes of grey-iron castings, and some British foundrymen agree with this. There are a number of British foundrymen who state definitely that one size of bar will not meet the situation, and say that three sizes of bars will better meet the situation, and it is in the endeavour to emphasise this latter view that this article is written. From Fig. 1 it will be seen that, given one size of bar, and material ranging from, say, 3.5 Si to as low as 1 per cent. Si, there will be a vast difference in the structure, and how it is possible to overcome this by one-size bar, would be interesting of explanation. If the bar is large enough to overcome the under-cooling effect in the low-Si irons, it will be too large to give comparative results in the softer or high-Si irons, which are used in the thinner castings.

The American specification meets this with varying loads, that is, the bar, when used with higher Si irons, has to stand less loads. This is quite in keeping with the statement that the test-bar does not represent the casting, but hardly follows the statement that the bar represents the material, as it is evident it does not, as the bar being heavier or of larger mass than the castings, it will have had a longer range of cooling, and therefore will have formed larger graphite flakes and not of the same material. Therefore, the test-bar which for cast iron is not made in relation to the mass of the casting, cannot be representative of casting or material in the casting, as it has not the same thermal history.

The whole of the foundryman's efforts should be to make a test-bar as nearly comparative with the casting as possible. This is not the worst feature of the one-size bar. In the event of the bar being used for a low-Si iron there is the chance of its becoming, through undercooling, of a mottled or white fracture, similar to that shown in Fig. 1—therefore unmachineable and useless for transverse test as given. Above a certain percentage of C.C. the breaking-load drops very quickly.

Overcoming Undercooling.

As far as the author's experience goes, there is only one way of overcoming this under-cooling effect, that is, to increase the size of mass of the bar to suitable dimensions to prolong the range of cooling and get a grey fracture thus suitable for test purposes. Again, if the white or mottled bar could be used it would not represent the castings, as if the castings had white or mottled fractures they would be unmachineable and of no service.

The author's reason for asking for three bars is that to be of service, and representative of the castings; they must not only have the same material in them, but undergo, as near as foundry conditions permit, similar rates of cooling, and therefore be somewhat like in structure; and, as stated earlier on, as the basis of cast-iron foundry practice is graphitisation, so also should all tests go through this process to be comparative. How can a white test-bar be machined or represent the strength of grey-iron castings? One may as well expect the malleable iron test-bar in the white or hard state to represent the annealed castings. This is a similar condition—the malleable bar has to undergo the same heat treatment and at the same temperature to become similar to the castings. So should the grey-iron test-bars have similar treatment, not annealing, but graphitise under the normal conditions of the castings to which they belong. Some may say that to be correct under these conditions an endless number of sizes would be required, but here again it is an attempt to meet a complicated problem, and at its best the results can only be comparative, and three sizes of bars will meet the situation where test-bars are necessary. The author is open to conviction that, as the Americans say, one size will meet the situation. If the other problems arising from this bar can be overcome it is easier to use one bar than three, but at present how to overcome the hard bars is a problem.

With malleable, the bar is made to suit the castings. Is it not correct to do the same with grey iron?

The question of fixing the data for the loads, transverse, reflection and tensile will have to be decided from experiment, which will not be a difficult matter when the situation as to the size, number and length of the bars is fixed.

Micrographs.

In a further endeavour to make the structure of cast iron more interesting, also to show under-cooling effect, a series of micrographs were prepared from the bars as shown, Fig. 1. These micrographs will be called, to simplify them, as in ordinary foundry parlance, grey, mottled and white.

Micrographs, G1, M1 and W1 (Fig. 2) plainly show the under-cooling effects on the C. These three are all of the same magnification, *id est*, 50 dias., plain-polished. G1 is of grey bar, shows graphite black, irregular half-tone area, phosphide eutectic, ground mass pearlite a typical grey iron. M1 shows two different structures, that of W1 and G1. One portion of the micrograph shows the grey area practically identical with G1, and another the structure is almost the same as W1.

This is what is called in foundry language a mottled iron. It will be seen in W1 that the graphite is not so pronounced as in the two previous, but there is still a small quantity to be seen. These micrographs show fairly well that the

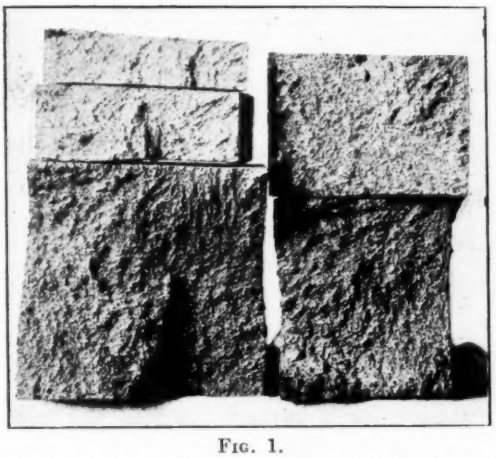


FIG. 1.

A series of bar cast from one runner. Their fractures range from grey, through mottled, to white. Actual size.

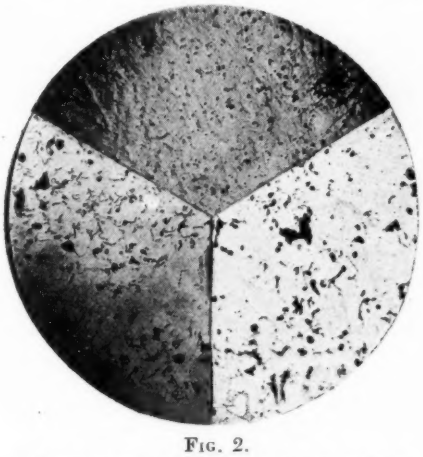


FIG. 2.

Shows micros, taken from the bars shown in Fig. 1. The right section is grey, the left mottled, and the top white. They have been simply polished, and magnified 50 dias.

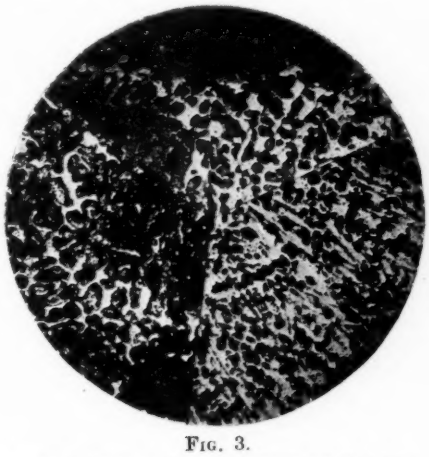


FIG. 3.

Shows the same sections as Fig. 2, but they have been etched with picric acid. Left section grey, the right white, and the top mottled.

change in graphite content is the cause of the different structures in the bars in Fig. 1, as all other constituents must be fairly equal by being all cast from the same ladle.

The structure of G1 is the strongest in grey iron, as it has graphitised with the formation of pearlite, and unless grey iron is properly graphitised one does not obtain this structure, which is obvious from the views M1 and W1.

As a further explanation of these, the next three micrographs (Fig. 3) will give fuller proof. G2, M2 and W2 are of the same magnification

FIG. 4.

Shows the same sections, but magnified 500 dias. In this case the white section is on top and the mottled at the right. They have been etched with picric acid.

FIG. 5.

Shows micro. G. 4 (right hand), which exhibits a phosphide eutectic area. It has been heat tinted. The left shows the phosphide (black areas), the ground mass being pearlite and graphite.

FIG. 6.

Shows in the left section W. 4, at 50 dias., heat tinted to show the phosphide eutectic. The top section, W. 5, shows the same section, but at 500 dias. The left section is W. 6, at 500 dias., etched with sodium picrate.

as the previous three, only treated in a different manner, that is, etched with a 2 per cent. solution of picric acid in alcohol. G2 shows a typical grey iron, white irregular network is the phosphide eutectic, and the ground mass the pearlite

with graphite. M2 plainly shows again the two structures of G2 and W2. That is, the grey area to the left, not so clearly defined as in G2, but nevertheless very similar. The area to the right is also like that of W2. W2 shows the white bar —the dark areas are pearlite—the white cementite which also contains the phosphide eutectic, which is not resolved, where etched, by picric at this magnification.

The next three micrographs (Fig. 4) are the same as G2, M2 and W2, only at 500 dia. G3 shows the pearlite, also the phosphide eutectic; M3 is not so satisfactory to show the difference, as it is not possible to get the two areas at this magnification. W3 shows the black area pearlite, the white the cementite, and half-tone the phosphide eutectic. G3, which shows so well the pearlite, is the structure of good, strong grey iron, and is what every grey-iron foundry should try to obtain, and this should be the structure of casting also test-bars.

These nine micrographs are those which are of most interest with regard to the test-bars and grey iron generally. It is proposed to show others as of further interest in the structure of irons.

G4 (Fig. 5) has been heat tinted, and shows a typical area of the phosphide eutectic, with the ternary eutectic at 500 dias. Fig. 5 also shows G5 treated with sodium picrate, shows black areas phosphide eutectic, ground mass pearlite with graphite.

The micrographs of the mottled bar are not so interesting in detail as those of the grey and white at above 50 dia., and they were not carried further. Fig. 6 shows W4 (50 dia.) heat tinted to show phosphide eutectic, whilst W5 represents the same structure at 500 dias., showing pearlite, cementite and phosphide. W6 at 500 dias. (sodium picrate) white areas pearlite, black cementite, irregular dark areas in centre, phosphide.

These micrographs are, no doubt, somewhat away from the discussion on test-bars, but it is hoped that they will show more plainly to readers the difficulties of obtaining sound castings with a material which is not homogeneous, being more a conglomerate, changing from area to area, and very sensitive to changes of temperature, as shown in Fig. 1.

Several Sizes of Test Bars Advocated.

The question as to whether test-bars are cast on or separate should be left to the foundries concerned. So long as they are made under as near the same conditions as foundry practice will allow and of the same material, it should meet the situation.

From this section of the article it will be seen that the author has tried to show why he considers that several sizes of bars are more likely to be representative of grey-iron casting than one size, and he feels it is a step in the right direction, for if engineers will have physical tests one must be prepared to meet them. Analysis should be at the option of the founder so long as he produces a material which will meet the physical test asked for, together with sound castings.

Now, after the whole of this discussion, the author is not in favour of any physical test-bars whatever, only to suit the purchaser. For good foundry practice none is necessary. From empirical data, foundrymen know enough of the strength of cast iron generally, and can tell if a certain structure is obtained, whether it will be a strong or weak iron within limits—there may, of course, be freak results. As with cast-iron castings, there is always a safe margin allowed in the strength, because of its liability to fail under shock, no fine limits are necessary.

Returning to Fig. 1, these bars were not cast for the purpose of illustrating this article, but are used in every-day practice to give the foundry a fairly correct idea as to the class of irons in use. This particular example was cast from the same ladle for a fairly large cylinder, and is used more especially in this case as a porosity test, which means that the foundry can tell very closely if the casting will withstand hydraulic test successfully. This method has been in use for some considerable time, and where the foundry becomes used to it it gives better results than either analysis or physical test. Analysis is the correct basis from which to work mixtures, and is the foundation of successful founding, but it does not go sufficiently far. It does not give the result of the effect of the other elements in the mixture. Taking analyses and sets of test-bars as shown, we get far more satisfactory results.

Use of Porosity Bars.

The author works with two sets at present, one ranging from $\frac{1}{8}$ in. thick, $\frac{1}{4}$ in., $\frac{3}{8}$ in., $\frac{1}{2}$ in. and 1 in., all are cast on one runner. The second set is as shown by thickness in Fig. 1.

The first set is used to represent castings from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. thick, the second from this upward to about 2 in. thick. These sets of bars are cast from the same ladle as the castings they represent, and are broken as shown, and then judged by fracture. This may seem a "rule-of-thumb" method, but it should be remembered that the author controls the mixtures as near as cupola conditions permit, by analysis, but this does not give the condition of the materials in the castings. There may be an alteration in the content of some of the elements in the mixture during melting, which cannot be traced by analysis. A mixture may be open or closed with practically the same analysis.

Taking the illustration of the bars from the cylinder, we aim at obtaining an almost white fracture in the bar 1 in. thick, and unless we obtain somewhere near this fracture porosity troubles result. This proves that the iron for the castings of this class is not as strong or close as it should be, and an iron that will stand up successfully under hydraulic test must be classed as strong material. There, the class of fracture, together with scientific control of the mixture, gives more reliable results than any physical test.

For the thinner or lighter castings the same method is adopted. We work to obtain a single chill in the thinnest bar. In the event of the mixture for thin castings being on the close side, the bars will show by the fracture if there are any hard castings cast from the particular ladle, and they can be examined accordingly.

Obviously it is only necessary for each foundry to adopt the size of bars most suitable for the class of castings to be produced, and to work accordingly. Some may object to casting bars in this manner, and adopt a wedge to show the chilling effect. This is not so reliable as plain bars of different sizes, as the heavy end of the wedge will anneal the thin end. Also, the plain bars are more representative, as they run in somewhat the same manner as the castings, being flat plates, which is the section in which castings are most often designed, and pouring with some mixtures makes a difference in the fracture, so we try to maintain the test in keeping with the methods in use in the production of the castings.

Taking again the cylinder casting (Fig. 1), a physical test of the material would not have proved the suitability of the material for this casting. We could have easily met this, but the castings would not be sound. We have now become so used to the method here shown that the foundry can give most reliable indication as to whether a casting has the correct material in it or not.

Non-Ferrous Work

The author has had this same position to face with non-ferrous castings, where the inspector would have a good test-bar. This particular job was gunmetal, and was being tested to 3,000 lbs. per sq. in., and was giving excellent results, being made with material to suit the job. On the other hand, the test-bars were not satisfactory, as being made they must be cast on.

To the author a pressure test is a sure sign of good material in any casting if it stands without failure, and how any inspector could scrap a casting because of the so-called test-bar when it was giving excellent results under more than normal working conditions is beyond comprehension. This was the case, and to overcome it we cast our bars from the same material, placed them in the mould and burnt them on. This shows that when test-bars are not in keeping with foundry practice we have to "fake" the results—an easy matter when dealing with people without foundry training. This should not be necessary if we could adopt sensible methods for giving some near idea

of the structure of the casting, and this is what is claimed is given by using a series of sections or bars in grey-iron foundry practice, and the author would be prepared to accept castings from such bars, provided they were not, of course, defective in other ways. If such bars give a good idea for a porosity test, they must also be relative to the physical state of the iron. We get an idea of the iron in several sections of the casting, which is obviously desired.

It may be said that fracture is a rather primitive idea to return to, but successful roll-founding cannot be accomplished without it. They gauge all their mixtures by the depth of chill. Each batch of iron is graded by this and used accordingly with excellent results, both here and on the Continent, and the manufacture of chilled rolls is undoubtedly scientific work. So also is the production of grey-iron castings to be successful under hydraulic or pressure test, and a method which is successful when used in both these cases should meet any grey-iron specification.

The primary object of the foundryman is to produce the correct casting for the job—test-bars are a secondary consideration. The sound casting with the correct material in it is invariably preferred, and the author would not want any tensile or transverse tests for cast iron, for no single size of bar to represent a casting can give as near the structure as a series of different sections which are cheap to make and require no machining.

Whilst analysis is imperative as a foundation on which to work, the fracture test, as shown, represents the condition of the material under foundry conditions and will meet most foundrymen's needs. It overcomes the difficulties which are met with in other methods of testing grey-iron castings.

This method also for the foundryman who has not a laboratory will be of service, as he can check his mixtures each cast, provided he procures an approximate analysis to commence.

Conclusions.

1. Tests of some kind are necessary for castings, and it is the foundryman's business to apply some reasonable test, also the engineer is quite within his rights to ask for and receive some satisfaction, which implies that whatever test is given by the foundry should be relative to the article produced, *i.e.*, a good test-bar should be representative of a good casting, and not as at present.

2. That the only means of making tests representative is for such tests to receive the same thermal history as the castings, and with special reference to cast-iron test, that is, the whole of the cast-iron foundry, which includes malleable, is based on graphitisation, the test-bars must be representative of this process.

3. That one size of test-bar for grey iron will not meet this process, as it will not give a grey bar in low-silicon iron, and therefore cannot represent a grey casting.

4. That three bars of different sections will be nearer the solution of the problem, and if a tensile or other test, etc., is asked for, this is the method which will meet most cases.

5. That as the method shown by casting a series of bars and examining the fracture is effective, and if, as stated, analysis is used for governing the mixture as charged into the cupola, then this series of bars cast under the same conditions as the castings, they represent, *i.e.*, dry or green moulds as the case may be; if near the same temperature as the castings not only gives a good idea of the structure of the material, but also is a guide to the chemist as to whether his mixture is correct for the work in hand, and it can be stated that we ourselves have found this method most useful.

The first time these bars were used was during the War, when asked to supply the so-called semi-steel castings. This method was adopted to ascertain how much mild steel certain mixtures of iron would carry without hardness troubles, and if a foundry has cupolas which melt iron satisfactorily they can be successful in the manufacture of semi-steel. These bars will show how much steel their particular brand of iron will carry in certain thicknesses of castings, and much of the success of using steel is to know what percentage to use in the class of casting to be produced, steel from 10 per cent. to 60 per cent., according to mass.

Wearing Capacity of Steel Rails.

Commenting on the relative wearing capacity of past and present steel rails, "The Railway Engineer" remarks that some 80-lb. per yard bull-head rails, rolled and laid in a British main line in the year 1879, were still in the same location in 1919, and it is believed that certain of these rails have not yet been taken out of the road. It is true that the route in question does not convey a very heavy traffic, but for all that, the fact that the combined effect of wear and corrosion on so comparatively light a rail section as this has not been enough to wear it out during over 40 years' life is sufficiently outstanding to call for special comment. A chemical analysis made from one of these rails gave the following percentages:—Carbon, 0.49; silicon, 0.120; sulphur, 0.085; phosphorus, 0.077; and manganese, 1.05. Thus in analysis the rail was in excess of the composition laid down in the British Standard Specification in force from 1904 until the revision of June, 1922, in respect of practically every important element.

The rolling of these early days was conducted at relatively low temperatures, with the result that a great deal of work had to be performed on the metal, in its passage through the rolls, before the ingot was finally reduced to the finished rail section. Herein is one reason why rails so high in carbon, phosphorus and manganese did not display the brittleness which might be expected in such circumstances. Another reason is that in the earliest days of the steel rail, the enormous increase of life that it gave, as compared with the previous iron rails, naturally commanded a very high price, and it was, therefore, practicable for a manufacturer to expend an amount of time and labour on his product that would be unthinkable to-day. The growing scarcity and cost of hematite ores led, both before and during the war, to so great an increase of basic open-hearth steel production that by the end of the war the supply of basic open-hearth rails to British railways had almost entirely superseded that of Bessemer acid rails.

There are now evidences that the tide has turned in favour of a rail of far harder-wearing qualities than that which was tolerated 10 years ago. Long before the 1922 revision of the British Standard Specification for rails, enlightened rail-users had begun to break away from the hampering provisions of the 1904 specification, and to make use of the increased control afforded in modern open-hearth steel-manufacturing methods by demanding, with their drastically limited percentages of phosphorous and sulphur, considerably higher percentages of carbon, and more severe tests. Manufacturers, on their part recognising the increasing demand for first-class material, and the growing keenness of competition, have been occupying themselves, at many of the larger steel-works, in modernisation of plant, striving to effect their economies in the handling of the steel rather than in its quality, with the result that, while steel prices have now fallen practically to pre-war level, the quality of the product both has been enhanced and still is in course of rapid enhancement.

Contracts Open.

Buenos Aires, April 26.—The Argentine Department of Sanitary Works are inviting tenders for 19 groups of vertical centrifugal pumps with electric motors and spare parts. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Dewsbury, February 24.—Construction of a 27-in. diameter cast-iron rising main, about 740 yards long, for the Corporation. Messrs. J. Diggle & Son, Brown Street, Manchester, or Mr. H. Dearden, borough engineer, Town Hall, Dewsbury. (Fee, £1 1s., returnable.)

Swansea, February 23.—Steel bridge work, for the Corporation. Mr. J. R. Heath, borough engineer and surveyor, Guildhall, Swansea. (Fee, £2 2s., returnable.)

THE LATE MR. P. DAVIES, of Danybraif, Pontardawe, Glamorgan, secretary of W. Gilbertson & Company, Limited, left £20,940.

Co-operation Between Drawing Office, Pattern Shop and Foundry.*

By F. C. Edwards, M.I.Brit.F.

At the outset it should be observed that the term co-operation, as used in the title, is intended to convey a deeper and more comprehensive meaning than it usually implies. By working amicably together, better collective results will be obtained than where there is a tendency to ignore each other's existence or to indulge in uncalled-for or destructive criticism. The most desirable results can only be secured, not by working together merely in an amicable manner as separate units, but by each department taking a genuine and sympathetic interest in the requirements of the rest, to the end that the best possible casting may be produced at the lowest possible cost.

Quantity Production.

The commonest slogan of the day is "cheap production," which does not necessarily mean low wages and slavery conditions in the workshop. On the contrary, it is often an accompaniment, if not indeed the direct result of, high wages and good workshop conditions, which connote, of course, humane management. Cheap production almost inevitably follows in the wake of willing co-operation and intelligent co-ordination of effort. Its attainment is most easily assured where trained thought—the natural solvent of hard labour—is utilised to the fullest extent. If there is one industry more than any other where thought concentration may be expected to yield fruit a hundredfold, it is that of the production of castings.

And yet how seldom do we come across a casting that has been designed to give a minimum of trouble to the moulder. It seems, indeed, to be the general practice to design castings with little reference to real foundry requirements. Then the patternmaker, for the same reason, perhaps—that is, lack of actual foundry experience—very rarely exhausts the many possibilities at his command for smoothing away the moulder's difficulties as he would do if he had to mould his own patterns. When the job arrives in the foundry, the usual orthodox attitude displayed towards it resembles that of the famous Light Brigade at the Battle of Balaclava, to the supposed orders of Lord Lucan: "There's not to reason why, there's but to do the job." Both pattern and design are beyond the pale of argument—sacred, so to speak—and all discussion is therefore taboo.

Occasionally, however, the foundry's proverbial patience is stretched to breaking point, and a story exists of a pattern being hurled across the foundry at the foreman patternmaker because it was the limit in its non-moulding attributes. The author has always held—in fact, it is one of his settled principles—that, as the moulder must mould the job, he is, right or wrong, entitled to have the pattern made as he wishes, so far as moulding is concerned. Acting on this principle, he has never experienced the slightest trouble in dealing with the foundry.

Co-operation of the Patternmaker.

The patternmaker should never hesitate to consult the moulder on doubtful points, even the simplest, for an apparently simple matter to the patternmaker may mean much in the foundry. He should point out the salient features on the blue print, especially those in which there is a possibility of extra tackle being involved. He should expound his own views, but he must accept the moulder's decision, and make the best of it.

This is just where a knowledge of drawing and patternmaking is of inestimable value to the moulder. It enables him to give reasoned decisions based upon clear views of the case, and he is, moreover, not likely to expect the impossible from the pattern shop. But there is another reason. They struggle and struggle in the attempt to produce the unproducible. That they frequently accomplish the seemingly impossible does not affect the case. It is, indeed, an argument for simplifying their work. Their prodigious energies ought to be directed into more profitable channels.

It may be laid down as a general rule that ideas for improvement should emanate, if possible, from the very spot where the improvement is to take effect. One who is part and parcel of a situation is naturally more able to sense possibilities and requirements than anyone who is not so intimately connected. What, then, could be more fitting than that the foundry should indicate to pattern shop and drawing office exactly where possible improvements might be made to facilitate and improve foundry production? It is the only way in which perfection can be attained in the production of castings.

Moulder's Sketching Ability Helps.

Useful suggestions relating to alteration in design or patternmaking, however, naturally imply some knowledge of these branches. It therefore follows that that foundryman is most qualified, and may be of most value to his firm, whether he be manager or operative, who, in addition to having a firm grasp of his own job, is also versed in drawing-office and pattern-shop practice. To offer advice on such a matter might be considered presumptuous, even if it were not altogether superfluous, but there are one or two courses of mechanical drawing that would prove very helpful to those foundrymen who experience difficulty in clearly visualising a blue print. A little practice in rough sketching is also well worth the time devoted to it. His everyday practice will, of course, provide the moulder with opportunities for becoming acquainted with the general principles of patternmaking, and by following the various articles on the subject which appear in the foundry Press, he may soon be in a position to make the pattern shop ashamed of its delinquencies.

In the pattern shop, blue print reading and the ability to set out a job, along with a general idea of foundry practice, is indispensable. But that knowledge should by no means be limited to a mere acquaintance with these branches. On the contrary, the patternmaker cannot be too well informed on matters affecting design, especially the design of the particular class or classes of work in which his firm is engaged, and he should keep abreast of the latest foundry practice. As a result, his own work will become more interesting, and he will be more likely to receive compliments from the drawing office and the thanks of the foundry in proportion as he constructs his patterns according to their respective requirements, and harmonises the whole. Incidentally, of course, his firm will also benefit.

The thanks of the foundry, speaking as a patternmaker, are indeed worth winning, and it should be the constant endeavour, as it is unquestionably one of the most laudable objects of the patternmaker, to strive to earn these thanks—to make the lot of those whose daily round is one of grime and sweat just a little easier.

Patternmakers Should Acquire Drafting Skill.

Not only should the patternmaker strive to acquire skill as a draughtsman, but he should take advantage of every opportunity that presents itself for learning the why and the wherefore of the various parts of the castings themselves, where the greatest stress and the nature of the stress is likely to be when the casting is in service, what machining is required, and so forth. With this knowledge, the patternmaker will be better able to decide the method of moulding so as to give the best all-round results. He will also be able to suggest to the drawing office where judicious lightening may be adopted, or where it is advisable to strengthen parts.

Visits to the foundry—and all patternmakers have access to the foundry at times, especially when their job does not go together properly in the mould—should be regarded as very valuable

* A Paper presented before the East Midland Branch of the Institution of British Foundrymen, Mr. Russell in the chair.

lessons. Notes should be made, and subsequent reflection will enable the patternmaker to formulate a kind of foundry science for himself, based upon his own observations, supplemented, of course, by relevant questions. By these methods the patternmaker will gradually become familiar with actual foundry requirements.

A Practical Example.

One of the regular lines in the foundry with which the author is connected is the making of side frames for weighbridges. These vary in sizes, ranging from 4 in. to 7 in. deep, 9 in. to 24 in. wide, and 7 ft. to 20 ft. long. The ends of these frames are standard for their respective sizes. This enables them to be bolted together end on end to form long bridges up to, say, 100 ft. long. Holes are cored for bolts, joggle recesses are cast in, and the ends are further relieved to reduce machining. It can easily be seen that such a face would present moulding difficulties, especially when the length of the patterns are taken into consideration. As a matter of fact, the ends of the moulds invariably collapsed to a greater or less extent on the withdrawal of the pattern. In many cases the impressions of the tail prints were completely lost, and in making up the mould variations naturally took place. The result was that complaints were constantly being received from the assembling department, because of the extra work entailed in chipping the holes to bring them into line.

Now, the author was the individual who had to face these frequent troubles, both in the foundry and in the assembling department, and soon realised the necessity for making a drastic alteration to the pattern. He had already suggested a little more care in rapping, with the idea, of course, of reducing end disturbance; in fact, on many occasions he had stood by whilst the pattern was being rapped and withdrawn from the mould. Then he had the strips tapered to the utmost allowable extent, which eased the situation a little, but produced no consistently good results. Finally, it became clear that the length of the frames, their weight, and the rapping required to get them out of the mould, necessitated an altogether different method. Block prints were screwed on the ends of the frames, and standard core boxes made to suit. The bolt hole cores were now made, of course, as part and parcel of the main core. Needless to say, this plain brick core pleased the moulders immensely, and, as no variation could possibly take place in the position of the bolt hole cores, no further complaints were received from the assembling department. Where the frames were run at the ends, suitable gates were put in the core boxes. Another advantage of this method was that the patterns were better able to withstand rapping, and were consequently more durable.

This is, of course, a simple case, but it will serve, perhaps, to illustrate the point that only when the patternmaker actually realises by direct observation of, and contact with, foundry troubles can he hope, so far as he is concerned, effectually to eliminate moulding difficulties.

Moulders' Co-operation with the Drawing Office.

It is a far cry from the nicely-warmed drafting room to the conditions of the average foundry. Everyone must admit that with a temperature round about zero, a smoke-laden atmosphere, and with damp sand underfoot, not to mention the possibility of having to work in loam, human fingers and faculties are likely to become numbed. The other extreme, of course—that is, casting during hot weather—is equally unpleasant.

These factors are introduced with a view to emphasising the need that exists for the draughtsman to accommodate design, so far as lies in his power, to foundry requirements, and a great deal lies in the hands of the draughtsman in this direction. We may safely assert that the design of a casting may be, from a foundry point of view, either good, bad or indifferent. In other words, an easy moulding design is often quite as satisfactory for its ultimate purpose as one that necessitates many loose pieces, say, on the pattern, or where extreme care is required on the withdrawal of the pattern to prevent serious mould disturbance.

A repaired mould is never so good as one where the pattern has left it undisturbed, and many a case of scrap casting can be directly attributable to faulty repairing of the mould due, in turn, possibly to bad design. We thus realise how essential it is that the draughtsman should have clear ideas appertaining to actual foundry practice, both in order to lighten the work of the moulder and to ensure better castings.

There is also the metallurgical aspect to be considered. Although experts differ in this field as to the exact sources of certain troubles, there is general agreement on the main lines as to what constitutes a well-designed casting. As in other professions, there are phenomena which are at present unexplainable, or which are explained in various ways, more or less contradictory. Nevertheless, and in spite of the assertion of a popular writer, that we know nothing, the laws of cause and effect governing the production of sound castings are pretty well known, and the designer of castings cannot be too well acquainted with these laws.

A Note of Warning.

The draughtsmen, of all men, is a mathematician. This is, of course, as it should be. Facility in the use of mathematical formulæ is indispensable to the draughtsman in dealing with relative dimensions, stresses, strains, etc. Indeed, he should take a delight in the use of this tool mathematics. The constant successful manipulation of a tool, however, tends invariably to engender in the mind of the user of that tool a too complete belief in its universal efficacy. Just as one versed, say, in the noble art of self-defence would solve all problems with—or without—boxing gloves, so it frequently happens that a high degree of mathematical skill actually militates against the perfect designing of castings.

Castings cannot be successfully designed on a mathematical basis alone, for the obvious reason that of no casting, however simple it may be, can it be truly said that the material of which it is composed is of an isotropic nature. By chemical analysis we know that different sections of the same casting are found to vary in chemical composition. We know by microscopical examination that even where there is similarity of chemical composition there may be structural variation, which implies, of course, a difference of strength. And, again, physical test of actual castings—not merely of test-bars, for a test-bar test, as is, of course, becoming increasingly recognised, whether cast separately or on the casting itself—is not a test of the casting; it is merely a test, and a local one at that, of the metal of which the casting is composed. Physical tests, then, of actual castings, and to destruction, reveal further differences in strengths between sections of identical dimensions but situated in different parts of the mould, and controlled by diverse factors.

Co-operation implies not only willingness but ability to realise each other's problems. The football team most likely to lift the cup is that in which the players, besides excelling in their own particular spheres, also understand each other's possibilities and limitations. The finest play is that in which a player delivers the ball to his colleague in such a manner as to enable him to make the best use of it.

Similarly with casting design, the draughtsman, in order to be successful, must become more or less mentally saturated with foundry practice. His decisions should be based upon a leaven of calculation and a great deal of experience. If he is wise he will value as pearls the words that fall from the lips of the practical foundryman, whose knowledge is the real thing. By the most reliable method of acquiring knowledge—that of trial and error—the experienced foundryman has built up for himself, unconsciously perhaps, something more than a mere theory of foundry practice. He stands upon the solid rock of personal observation. He deals in facts—facts whose existence, after many failures perhaps, he has placed beyond the realms of doubt. This explains why he is inclined to be dogmatic, and to look askance at the mere academician.

The practical foundryman knows, almost at a glance, where a badly designed casting is likely to give way owing to the influence of uneven cooling. He will calculate—without the aid of a slide rule,

and in less time than it would take to look up a text book on the subject—exactly what is required to secure equilibrium of internal stress. This may involve adding more metal, judicious lightening, or simply exposing the casting at the heavier sections to hasten cooling at those parts. He may even suggest an addition of metal to be subsequently machined off again. In any case we may depend upon it, he has substantial grounds for the course he suggests, though he may not be able to furnish what is termed a technical explanation, and why indeed should he explain? His conclusions are based upon the cumulative evidence of direct personal observation of similar and probably identical cases. Let others formulate theories, he is in possession of the facts.

If the draughtsman were to follow closely these cases, making a few notes and sketches to assist memory, and for purposes of comparison, and taking full advantage of the lamp of experience, he would be better enabled to design evenly-proportioned castings combining a minimum of metal with a maximum of strength. Just as the strength of a chain is that of its weakest link, so a casting cannot be stronger than its weakest part. Of what avail, therefore, is it to design one part of a casting excessively strong and to ignore its general strength? Excessive local strength invariably constitutes, in itself, a potential source of weakness.

To sum up, then, the strength of a casting cannot be even approximately gauged merely by reference to the sectional area of some part of it and the breaking load of the metal obtained from a test-bar. The disturbing agents vary not only in kind and degree, but their incidence is peculiar to the special circumstances of each individual case. The training of draughtsmen in casting designs cannot, therefore, be neither based upon book lore, nor *a priori* reasoning, but personal contact with the actualities of foundry practice will qualify the designer to co-operate—as he ought to co-operate—with the foundry in the production of sound and easily-produced castings.

As the success of the foundry depends upon the close working together of draughtsman, pattern-maker and moulder, it must follow, as a necessary corollary, that the most perfect interlocking of activities can only be secured where each is well acquainted, at any rate with the principles of the other's work.

Wasters Call for Co-operation.

The importance of this general power of speaking each other's language is never more clearly realised than in the case of an inquiry into the cause of a scrap casting. Every foundryman has had experience of these more or less painful cases, where someone must shoulder the blame, and sometimes a poor scapegoat is found, and the blame is not justly apportioned. Naturally—since self-preservation is the first law of nature—each individual endeavours to clear himself, but it is also natural, as well as the first duty of a man, to strive to secure the good opinion of his fellows.

Where there is adequate illumination, and everyone is able to explore the various nooks and crannies of a case, veracity and straight dealing commends itself very strongly indeed to all the participants in the inquiry, and there is obviously not much to fear of the blame being wrongly apportioned.

There is also a far-reaching psychological effect which directly conduces to all-round efficiency. Each departmental chief realises that in case of an inquiry nothing can be hidden. He watches, therefore, with meticulous care that trouble does not emanate from his quarter. The result is—fewer mistakes and less need for inquiries. Can anyone imagine a healthier condition of affairs in any industry? For we should remember that the chief's attitude is bound to be reflected in that of his subordinates throughout the whole of his department, and his efficiency is multiplied accordingly. There is a general realisation, in short, that eternal vigilance is the price to be paid for a clean slate.

Advantages of Co-operation Summarised.

Obviously the advantages of sympathetic co-operation are at least fourfold (1) By taking a real live interest in the work of our colleagues we may give them material assistance—obviously we can only render aid where we realise requirements. (2) We are so much the better able to plough our own furrow—this is in accordance with the true old saying, that "to know everything about something, we should know something about everything." (3) We can the more effectually defend ourselves in case of necessity, and (4) The firm is bound to benefit both pecuniarily and in reputation—that, of course, goes without saying.

Foreign Competition.

We are constantly being reminded of the alleged decadence of British industry. We have, in these islands, the finest brains in the world, with an inherent craftsmanship second to none, and we have, the world over, a reputation for fair dealing—a big asset in any business negotiations. In this connection it is interesting to note that in South America they use a term "Palabra Ingles," which means "the word of an Englishman." To them it is synonymous with reliability, and signifies that the goods can and will be delivered.

One who had travelled and worked as an iron-moulder on the Continent and in the United States said that when a Britisher takes off his coat he has not an equal in the wide world.

By means of real co-operation between draughtsman, pattermaker and moulder, that live sympathetic co-operation, that the Author has endeavoured in a small way to delineate—the British foundryman, with his inherent superiority, can, and will, lead the world in the production of castings.

DISCUSSION.

MR. RUSSELL, the Chairman, said it was a distinct advantage to be able to read thoroughly a drawing, which was not an easy thing. On being asked the best way to do a certain job, and on being shown a drawing, and though one might have had a fair experience, he confessed that at first it was very difficult to visualise what the drawing represents and imagine the castings. There were now facilities to learn at the Technical Schools, and it would be of great assistance to a moulder who wants to progress in his trade. The lecturer made a strong point also that the moulder should understand pattern-shop practice. There, again, it was almost impossible to get that practice, but he could learn a lot by looking at the various patterns and getting a general idea of the various wood-working machines now used, more particularly the band-saw and various planing and surfacing machines. He would get an idea roughly how the pattern was made, and what looks like unnecessary work may be essential if one is to have a pattern sufficiently strong and rigid to secure the desired result, such as a corner blocked-up. It is extra work for a moulder, but he would find it was almost essential to get a strong job. It was really rather wonderful to think of the amount of experience that has gone into the making of castings, and the very haphazard way, so it appears on the surface, in which some moulds are made by men who are, after all, to a great extent uneducated, but show a marvellous knowledge of some of these jobs. Many can turn over a job without any hesitation and without any calculation; all done, not by rule of thumb, but as a matter of accumulated experience. In these days of subdivision of labour, it is amazing to have to find a number of well-skilled men, who can make a job from start to finish without supervision or advice, although they appreciate it, but nevertheless you can leave the job to them, and in 99 times out of 100 they will get a real good casting first time.

MR. LOUCH, who asserted he was in the middle position, a pattern-maker, said he quite realised how much better for the three sections it would be if they co-operated more. His difficulty was to get the draughtsman to realise that the workman has some intellect, yet he could suggest alterations the draughtsman would think presumptuous. He recalled one place where there were over 200 moulders, where it was always the policy of the management to bring the foreman moulder and the moulder who was to do the job to consult with the pattern-maker. There was no doubt that, at times, he was in trouble as to the best methods of pro-

duction, and often five minutes with the moulder relieved him of many hours of anxiety. The three trades were so combined that it was necessary that all should try to get the best results. How often one heard the moulder say: "He ought to make another thing like this and shoot himself." It was far easier to criticise than construct. He had worked from blue prints produced all over the world, and often had to use his own judgment; yet, if he could have had five minutes with the draughtsman, matters would have been simplified. There were many such patterns, but the ordinary pattern-maker was not allowed to make suggestions, and, on the other side, many a moulder could make a better job if allowed to make suggestions to the pattern-maker. The workman was presumed to have no knowledge. There were many suggestions to be made for simplifying, and so cheapening the cost of production, if the draughtsman would not be so autocratic. He said, after great experience, that the English draughtsman was the worst for a moulder to work from than any other draughtsman in the whole world.

Foundrymen are up against competition, and must make things simple, if they can be arranged, and so get cheaper cost of production. To-day patterns were too often made by pattern-makers who did not study moulding at all, but simply made as cheaply as possible, and put the responsibility on the moulder. If a pattern-maker was told to turn out a pattern for £5, and it was worth £6, he knocked a bit off and sent it on to the moulder, who in turn made the remark mentioned before. There was one thing a draughtsman did not study, and that was strain on the moulds of big castings. He will not keep his facings high enough; a casting weighing 10 tons springs. The draughtsman should go into the foundry, and the pattern-maker also; but to-day the average pattern-maker never sees the foundry.

The pattern-maker started with a clean piece of paper, and knew nothing about foundry experience. But the designer, in addition to having to study the moulder's standpoint and the pattern-maker's standpoint, has also to study the people who are going to machine the casting. They did not rely so much on mathematics, for the trained designer knows perfectly well the limitations in that direction, and unless one is seriously drawing near to the danger zone, one does not consider mathematics more than can be helped. He would suggest they should get an intelligent foundryman—a youth who had started with some technical training—and train him to be a draughtsman. He would be a good man to deal with the question of castings. He thought the draughtsman should first of all co-operate with the pattern-shop, and not so much with the foundry, and the pattern-maker should keep in touch with the foundry. It would be preferable to follow a job right through, but that could not be, owing to the subdivision of labour. The pattern-shop should be thoroughly conversant with foundry practice, and so constitute the link in the chain. In that connection the designer can materially help the pattern-shop by plenty of section. Reasonable notes should be given, if only on the blue print, by explaining essential factors. For some particular reason, one may not be able to get a taper in a particular direction, and, if the moulder emphasises that, the pattern-maker will do his best.

The point should be, how best can the pattern-maker help the moulder to do his job—not how cheap can the pattern be made? He was sure that this co-operation was leading to very much better results than previously, but there was still room for more.

MR. ROBINSON said he had always believed in co-operation; in fact, in any difficulty, he asked the pattern-maker, or they consulted the foreman moulder—they got the three together, and it paid.

MR. A. S. CLARKE proposed a vote of thanks, and said it had been a source of education to listen to the lucid lecture. There was a lot of truth in it.

A SPEAKER, in seconding the vote, said the difficulty with co-operation had been that, in the foundries, one did not come across an intellectual man in a thousand. It was a pity, but it was true. He was glad co-operation was coming about, but the moulders must pull up their socks and get into a better way.

In reply to the vote, MR. EDWARDS said he deeply appreciated their kindness, but, in justice, would say that 50 per cent. at least of their vote was due to the Editor of THE FOUNDRY TRADES JOURNAL for suggesting the idea of the Paper. With regard to Mr. Louch, he had never had any trouble with draughtsmen; men who were first-class pattern-makers and moulders had to concentrate on their jobs, and often forgot other things, but they were helping to carry on British trade.

New British Chemical Standard.

Basic Slag "A."

The organisers of the British Chemical Standards Movement announce the issue of a basic slag standard. The special uses of the slag are:—(1) Primarily as an analytical standard for total phosphoric acid and phosphates. (2) In addition, as a standard mainly for basic steel makers, but also for acid steel makers, iron and steel founders, and others, to enable them to check their methods for silica, iron, lime, and magnesia, etc., in slag. The analysis is as follows:—Phosphoric anhydride (P_2O_5), 12.93, equal to phosphates ($Ca_3P_2O_8$), 28.24; iron, 8.97; and silica, 16.15 per cent.

During the standardisation of this slag the need for such a standard has been made abundantly evident to the organisers, for it has been found that, even in the determination of such elements as iron, silica, lime and magnesia, which, it may be thought, present little or no difficulty, improvements in methods have been essential in order to get agreement between experienced chemists.

The standard has been tested by a selection of 16 prominent chemists, representing independent analysts, both metallurgical and agricultural, the U.S. Bureau of Standards, English and French iron and steelworks chemists, and English basic slag grinders and merchants.

The standard sample may be obtained in 100 or 50-gramme bottles, either direct from organising headquarters, 3, Wilson Street, Middlesbrough, or through any of the leading laboratory furnishers, at a price just sufficient to cover the cost. A certificate giving the names of the analysts co-operating, the types of methods used, and a detailed list of the results will be supplied with each bottle. A special new feature of this certificate is the very full notes on the methods used by the different chemists. It is hoped that chemists will take full advantage of this standard, which has been prepared for their mutual benefit.

Catalogues Received.

THE NATIONAL ENGINEERING COMPANY, 549, W. Washington Boulevard, Chicago, U.S.A.—A Pamphlet describing the Simpson foundry sand-mixer, which embodies some novel features.

THE GLOBE PNEUMATIC ENGINEERING COMPANY, LIMITED, 1, Victoria Street, London, S.W.1.—A Brochure dealing with air compressors and vacuum pumps.

MELDRUM, LIMITED, Timperley, Manchester.—Details of the Meldrum oil burner, which, we note, is suitable for annealing furnaces.

THE BETHLEHEM STEEL COMPANY, Bethlehem, Pa., U.S.A.—An illustrated catalogue describing Mayari pig-iron, a material which naturally contains nickel and chromium.

Newcastle Institution of British Foundrymen's Branch-President Honoured.

The Institute of Marine Engineers has awarded to Mr. H. J. Young, F.I.C., a silver medal for his Paper on "The Problem of Grey-Iron Castings." He will receive this from Admiral Sir George Goodwin, the President of the Institute of Marine Engineers, on April 6.

The Royal Agricultural Society of England announce that the Royal Show is this year to be held at Newcastle-on-Tyne from July 3 to July 7. No less than £14,750 is being offered in prizes.

The British Industries Fair—Birmingham Section.

This exhibition, which opened last Monday at Castle Bromwich, contains much of interest for foundrymen, though it is primarily intended for overseas buyers. For many years it has been customary on the Continent to hold annually, or even semi-annually, large trade fairs of this nature. Leipzig and Lyons are, of course, the two most important. Climatic conditions allow of these being held in the streets and boulevards, but, so far as Lyons is concerned, the tendency is to construct large exhibition halls, so as to make conditions more comfortable for buyers. Good progress has already been made in London and Birmingham to make these annual shows appeal to the foreign buyer, just as much as Leipzig and Lyons have done in the past. Amongst the exhibits to which foundrymen should pay special attention is that devoted to the Association of Drop Forging Manufacturers, as here they will see some of the inroads which are being made into their industry.

RAW MATERIALS.

Messrs. Consett Iron Company, Limited, of Consett, County Durham, are showing many manufactures in which foundrymen are vitally interested.

Hematite Pig Iron.—In this section various grades of hematite pig-iron, including a special low silicon pig, suitable for chilled castings, will be on show.

Coke.—Garesfield beehive coke is well known in both the home and export markets for its high-class quality for foundry and other metallurgical purposes. Two patent by-product cokes—Consett and Langley—will also be shown.

Silica Bricks.—Silica bricks for use in steel works, gasworks, ore-briquetting plants, foundries, coke ovens, and other places where a highly refractory material is required, are being shown, not only as squares but also in a number of difficult shapes, of which this house makes a speciality.

Firebricks.—"Bute" and "Delves" brands of firebricks are largely used by the most important iron and steel works and producers in the North of England.

PREPARATION OF RAW MATERIALS.

Messrs. Hollings & Guest, Limited, Thimble Mill Lane, Birmingham, make a speciality of presses and pumps. For foundrymen, however, their hydraulic scrap bundling press is of chief interest. It consists of a rectangular cast-iron box 27 in. by 15 in. by 30 in. deep, with a hinged cover. The hydraulic ram is arranged underneath this box, with a table which fits closely inside the box. The whole apparatus is let into the ground, so as to bring the top of the box to a convenient height for throwing in the material. The box is filled with old tins, and other material to be dealt with. The lid is then swung over, and the pressure turned on by the valve. As soon as the maximum pressure is reached, as shown by the pressure gauge, the operator releases the valve, and swings off the cover, and the ram ejects the bale from the press.

The average size of the bale produced in the standard press is 27 in. by 15 in. by 6 in., and weighing 1¼ cwt. approximately, depending on the class of material being dealt with. The press is suitable for bundling old tins, scrap kettles, and general town refuse. Also for old wire, sheet iron clippings, and any scrap metal of this description.

PATTERNMAKING.

Messrs. The Mechanical Engineering Company (Manchester), Limited, 5, Nicholas Croft, High Street, Manchester, are showing specialities of outstanding interest for patternmakers.

Panel Planing and Thicknessing Machine.—The body is cast all in one piece. The timber is fed by self-acting feed rollers driven by gearing, and the rate of feed can be altered. The feed rollers can be stopped independently of the cutter block, and the gearing is placed at the back of the machine quite out of the way of the operator. The cutter block is of forged steel, triangular in shape, carrying three knives fixed on twist to give a shearing cut, and runs in self-oiling bearings of the best phosphor bronze. The special shape of cutter block ensures the very best results in planing; there is no chopping or digging in; the wood is cut off in a clean shearing cut, leaving a perfectly smooth surface. The table is moved by a screw motion, actuated by a hand wheel. A rule and pointer for setting the machine to plane to a certain thickness are affixed to the machine in a convenient position.

This machine will plane and thickness either hard or soft wood from 1-16 in. to 7½ in. thick without leaving any perceptible ridge or unevenness.

The "Toledo" Hand-Planing Machine.—The body of the machine is cast all in one piece. The tables are mounted upon planed slides, and each table is provided with a horizontal adjustment so as to allow them being brought back for adjusting and setting the cutters. They are also adjustable vertically independent of each other, and cannot be lowered into the cutters. The fence is adjustable across the table and will cant to any angle for bevel planing, and is fitted with two holding-down springs.

Hand-Power Mortising Machine.—This is a direct-action mortising machine. A wrought-iron lever is directly over the chisel, so that a large additional power is obtained, doing away with the wear and tear of the usual side crank pinion wheels and toggle motion. The chisel is held firmly, as it does not rely on a spring to keep it in position. In fixing the chisel in spindle, set the face of chisel square with the fence of tray, and in mortising the face of chisel must meet the cut.

The "Reliant" Circular Saw Bench.—The table is mounted on slides at each end of the bench, and is raised by screw motion actuated by a hand wheel at the fence end of the bench. The table has a groove planed in for cross-cutting carriage to slide on. A rule is also stamped on the table, so that the fence can be set to the inches required without stopping the machine.

Disc Sandpapering Machine.—The standard is a substantial hollow casting in one piece with large base. The bearings are of large diameter, and bored in the main standard, thus ensuring the greatest rigidity. They are phosphor bronze of the ring-oiling type. The tables are accurately planed and grooved to take fence. They are adjustable upon V slides to and from the disc by screw and hand wheel, and will cant to 45 deg. angle.

The disc is 30 in. dia., and fitted with a conical steel ring to draw up the paper tight, and can be renewed in a few minutes. No part of the disc is visible except upon the working half face.

Band-Sawing Machine. — In this band-sawing machine everything has been done to reduce the breakage of saws, and to improve both the quality and the quantity of the work produced by it.

The frame is cast in one piece of box section, very strong, and to it are fitted all the working parts, thereby securing accuracy. The table can be canted for bevel cutting. The fixed table covers the bottom saw pulley, thereby preventing pieces getting under the saw.

There is a spring tension to compensate for expansion and contraction of saw, and a brush to keep rim of bottom saw pulley free from sawdust, resin, etc. There is an improved method of hanging top saw pulley to reduce strain and friction on saw to a minimum, which can easily be adjusted so as to run the saw on any portion of the rim of the saw pulley.

Chain Mortiser.—This will carry chains up to ⅞ in., and is also made with attachment for square chisels up to ⅞ in. square. It wil cut mortises up to 6 in. deep, and handle timber 12 in. by 7 in.

The firm will be represented by Mr. E. Shelson, managing director, and Mr. T. S. Crosby, their Liverpool representative.

FOUNDRY SPECIALITIES.

Messrs. Carbic, Limited, 51, Holborn Viaduct, London, E.C.1, are not showing their acetylene specialities, but are confining their exhibit to Otis King's Patent Calculator. This is a new development of the slide rule, and is made up in the form of a cylinder 6 in. long by 1 in. dia. It consists of three parts: (1) A holder with a fixed scale; (2) a cylinder with a sliding and rotatable scale; (3) an indicator. It is made up in two models, one for general use and the other for engineers. It is undoubtedly more handy for the pocket than the ordinary slide rule and probably more accurate than the type made up in the shape of a watch.

Nobel Industries, Limited, are showing explosives, ammunition, machinery of different kinds, metals, hardware and collodions. Amongst constituent companies represented having interest for our readers are: Continuous Reaction Company, Limited, Necol Industrial Collodions, Limited, and Thermit, Limited. Industrial collodions have made great strides in recent years, and the exhibit of the products of Necol Industrial Collo-

dions, Limited, will include Necol plastic wood as used in the foundry and engineering trades and for repairs to woodwork generally, and "Necolustre," a novel article for preventing the tarnishing of bright metals. Other applications of Necol products for lacquering metal ware, coating leather, wood finishes, etc., will also be shown. Another feature of interest is the showing by the Thermal Company of the aluminothermic process, which may be summarised as follows:—(1) As giving by means of titanium thermit clean, close-grained castings and the prevention of blowholes; (2) the reheating of sluggish metal in the ladle with its attendant benefits; (3) the melting of steel in cast iron to produce semi-steel; (4) the manufacture of small castings; (5) repairing flaws in castings; (6) for alloying purposes. Then, of course, there is the welding of castings by the thermit process.

FOUNDRY EQUIPMENT.

Alldays & Onions, Limited, have as principal exhibits an automatic stamp and drop hammer, planishing hammer, and a new type of spring hammer, with several novel features. Some of these have interest for steel-casting manufacturers as they are handy for testing furnace samples.

The firm, as is generally known, has been established 270 years, and it is quite refreshing to see a company of this extended age still alert and ready to develop new ideas.

Turning to relatively smaller articles on Alldays & Onions' stand, there is the F.O.5 forging furnace, arranged for either gas or oil firing. The furnace opening is 12 in. long, 12 in. deep, and is suitable for taking bars up to 1½ in. The furnace is fitted with the burner arranged for low-pressure blast. The air pressure required when thus arranged is 14 in. to 21 in. water gauge. The furnace has a deflecting air pipe as well as a screen to protect the workman from the heat. A welding heat is easily obtainable.

Blast is provided by their No. 22 Duplex Blowing Fan, which for many years has attained world-wide reputation for high pressure, efficient working, and general excellence. The test of a centrifugal fan is the amount of air delivered at a given pressure per h.p.; on that test the Duplex will compare with any commercial fan. The fan is fitted with ball bearings.

The Climax Hearth here is fitted with a separate electrically-driven fan, the whole self-contained. The fan set can be arranged to suit any electric supply. The advantage of this will be readily understood, as when installed in the smithy there is no loss of power. This is the most up-to-date and economical form of equipping a smithy.

A suitable complement to the above-mentioned climax hearth is the S.10 Roots Blower. Very careful consideration has been given to its manufacture and, by the aid of the most modern machine tools and skilled labour, the article has been turned out highly efficient. The company manufacture a full range of these blowers, from the smallest, with an output of 0.042 cub. ft. to 110 cub. ft. per rev.

The Empire positive pressure blower has been designed as a medium between a Roots blower and an air compressor. The air pressure is specially suitable for gas and oil furnaces, brazing, sand blasting, steel convertors, or any work requiring a uniformly steady pressure of 0 to 10 lbs. per sq. in. Very simple in construction, and positive in action, this pressure blower has the further advantage of being constructed with no gear wheels.

Holt & Willetts, Lion Works, Cradley Heath, are showing a number of overhead cranes, both electric and hand-power. There is a large assortment of pulley blocks and much other lifting tackle which cannot fail to interest our readers.

Messrs. Lucas Furnaces, 45, Newhall Street, Birmingham. This firm's exhibit is of very considerable interest to all users of furnaces. They have several important innovations, the chief of which is their Patent economiser oven furnace, which maintains the temperature in the chamber right up to the door while it is open in a straight cut line, and with a distinct non-oxydising atmosphere in the chamber. The natural draught furnace is suitable for all operations up to 1,100 deg. cent., and an adaptation of the same system is applied for the high-temperature furnaces.

In the high-temperature furnaces they include an improved silent attachment to the interior of the furnace which breaks up the force of the flame and distributes same uniformly over the chamber, thus doing away with the troubles experienced by the direct impingement of the air-blast burner on the walls of the chamber and on the work. Users of these furnaces will appreciate the advantages obtained and should not fail to see this exhibit.

In addition to these they are showing an improved incinerator which is being adopted by a number of gold and silversmiths for reducing sweep. They are also specialising a case-hardening compound, pyrometers, and other equipment for the heat treatment shop.

It is useful to know that the natural draught furnaces are in use for enamelling on metals and firing colours on glass. They have also brought out a continuous core-drying oven. Their representative, Mr. Bawden, will be in attendance throughout.

FETTLING.

W. Canning & Company, Limited, Gt. Hampton Street, Birmingham, are exhibiting a complete range of machines, plant and materials for general electroplating, polishing, bronzing and lacquering.

Of interest to brassfounders are their belt-driven polishing lathes, electric polishing motors, trapping and polishing machines, polishing and burnishing barrels, polishing mops, felt polishing bobs, compressed canvas and leather books. Associated with these are a number of proprietary brands of polishes, such as Tripoli and rouge composition, "Lustre" and "Peerless." Of more general interest, however, are the foundry brushes shown, the principal one being the "Reliance" steel wire circular type for cleaning castings.

"Reliance" foundry parting sand is another speciality of this house.

Messrs. G. D. Peters & Company, Limited, of Caxton House, Westminster, are showing a number of motor-coach work accessories, but for foundrymen it is their Wilson plastic arc electric welding plant which is of most interest. This plant consists essentially of a motor generator and a control panel. Another exhibit of interest is the Railodok electric truck. These trucks are extensively used with very successful results by railway companies, dock and harbour authorities and industrial houses. They are made in the ordinary straight platform box and drop-frame type, and have also various accessories suitable for the particular work in which they are employed, such as an elevating platform, barrel lifters, and small crane attachment.

The British Oxygen Company, Limited, Lodge Road, Hockley, Birmingham, are exhibiting oxygen metal-cutting apparatus, oxy-acetylene, oxy-hydrogen and oxy-coal-gas welding blowpipes, high-pressure gas regulators, and a large variety of high-pressure gas apparatus. This firm, who are the originators of the seamless gas cylinder industry, are also manufacturers of plant for the production of oxygen (in liquid or gaseous state), hydrogen and other gases, gas compressors, etc.

TESTING.

Messrs. W. & T. Avery, Limited, have an interesting selection of testing machines of special interest for the foundry.

Avery Universal Testing Machine.—The compound lever type of testing machine is sometimes preferred by users on account of the smaller space it occupies, as compared with machines of the single-lever type, and also because of its easy adaptability for the testing of specimens of considerable length. The main weighing levers, which are all fitted with hardened steel knife edges, are fully enclosed within the base, and connect up to the steelyard placed at a convenient height for the operator. The straining system consists either of a hydraulic cylinder and ram, or it may be arranged with change gears, driven by belting from an existing countershaft.

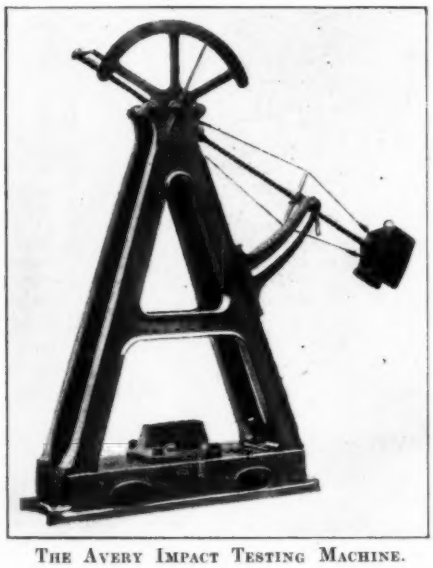
The main shaft in power-driven machines communicates to the straining screw through the medium of worm bearing, thus providing the smoothest possible method of straining, several changes of speed being provided to facilitate the testing of every kind of material.

The "Avery" Impact Testing Machine (Izod).—The "Izod" test for brittleness is well known amongst steel manufacturers, and is worthy of consideration by the ironfounder. It has long been recognised that the tensile test is not a sufficient guide to the value of steels when employed in situations rendering them liable to shock. Under such conditions the tensile test can usefully be supplemented by the "Izod" impact test. Without its use a steel cannot be properly heat-treated to give its best shock-resisting qualities. The "Avery" machine for carrying out this test is 120 ft. lb. (17 kg.m.) capacity, the specimen being 10 m/m square in section, and notched at its front face in accordance with the standard specification.

The energy imparted to the specimen by the swinging pendulum is immediately indicated by the pointer upon the graduated quadrant.

Supplementary tools to enable round specimens to be tested can be supplied, if desired; the specimen in this case conforming to the specification laid down by the British Air Board. A smaller size of machine is also made, namely, 23 ft. lb., the specimen being

¾ in. by 3-16 in. (10 m/m by 5 m/m) in section. This size of machine is useful where it is not possible to cut the specimen for the larger machine from the material under test. The Impact Test also has been applied to timber, cast iron, aluminium, and



THE AVERY IMPACT TESTING MACHINE.

various other materials, and has afforded most useful information.

The Avery Patent Hardness Testing Machine (Brinell).—The "Brinell" test for hardness is well known, and consists in the application of a standard load of 3,000 kilogs, to a steel ball 10 m/m in diameter, in order to force it into the surface of the material to be tested. The "Avery" patent machine for carrying out the above test is designed throughout on the weighing-machine principle, ensuring beyond doubt that the specified load is accurately applied and maintained. Most foundrymen are familiar with this system.

FINISHING.

The Midland Fan Company, Limited, of 212, Aston Road, Birmingham, are showing complete spraying plant for the spraying of paints, enamels, lacquers and varnishes, and they will be able to demonstrate possibilities on the spot. The Midland Sprayer Pistol is used extensively in foundries for applying blacklead, and also for painting castings. This firm specialises, as their name implies, in dust extracting and other ventilating work. Mr. Passey is in attendance at the stand.

FOUNDRY PRODUCTS.

The Delta Metal Company, Limited, with important works at London and Birmingham, are showing a great variety of non-ferrous metals and alloys in which they specialise. This company are the pioneers and largest manufacturers of extruded rods and sections, and the great range of specimens of these shown by the company gives a good idea of the enormous scope of the extrusion process in the trades and industries in which non-ferrous metals are employed. Briefly, the extrusion process, the invention of the company's late chairman and managing director, Mr. Alexander Dick, consists of the pressing of the heated metal through a die having an orifice corresponding to the section desired. The sections shown range from pinion wire and other small shapes weighing a few ounces per foot to heavy angles, rods and special sections of forty pounds and more per foot run. These are produced in brass, yellow metal, white metal, naval brass, bronzes, copper, etc., either in special complicated shapes and forms or as plain, round, hexagon, square, flat and other rods and bars, in lengths as required. Brass and bronze pressings, stampings and forgings are shown in great variety, also castings, sheets and tubes, etc. Numerous test pieces illustrating the strength, tenacity and ductivity under hot or cold working conditions of the various metals and alloys made by the company will be of particular interest to engineers generally. The Delta Metal Company, Limited, was founded in 1838 by the late Alexander Dick, and incorporated in the year 1888. Mr. G. H. Gurney will be in charge of the stand.

Messrs. John Harper & Company, Limited, Albion Works, Willenhall, Staffs. This firm have on show a full range of castings made in high-tensile iron (semi-steel), grey iron, and malleable iron. The firm make a speciality of tackling difficult castings, which their specialised plant allows them to make.

Messrs. E. J. Smith & Company, of Tyseley Metal Works, Birmingham, have a very interesting exhibit if ingots in all non-ferrous metals and castings of many kinds. Messrs. A. A. Jackson, G. H. Stampe and H. C. Rhodes will be in charge of the stand ready to answer queries

Messrs. Bradley & Company, Limited, exhibit includes tinned, japanned and galvanised hollow-ware, Beldray specialities, such as Albion baths, kettles, baking pans, etc. Also a large range of metal ware in copper and brass, including the novel "Satinette" finish.

Messrs. The Coalbrookdale Company, of Coalbrookdale, Shropshire, are showing "Servall" grates, Major and Minor, also "Warmall." Messrs. E. L. Herbert (sales director of Light Castings, Limited) and F. Fowler are in charge of the stand.

Messrs. Royles, Limited, iron and brass founders, Islam, Manchester, are exhibiting steam specialities which have a dual interest for foundrymen as being both a foundry product and as used in their power plants.

ALLIED INDUSTRIES.

Messrs. J. B. Stone & Co., Ltd., of 135, Finsbury Pavement, London, E.C., are showing the "Wilson" patent nibbling machines, which have been specially designed for the rapid cutting of all kinds of sheet metal, including cast steel. The machine consists of an overhanging arm carrying a rapidly reciprocating punch of small size, which works over a female die carried by the bed plate. The feed is governed by a small stop on the extreme end of the punch. The metal is fed against the pin, allowing a small portion of stock to be removed with each stroke of the punch. This arrangement permits the cut to be from any direction, the value of which is readily recognised.

Messrs. Accles & Pollock, Limited, of Oldbury, Birmingham, have an exhibit which should interest all metallurgists, especially so is the show-case of different sections containing about 2,000 separate pieces of cold-drawn weldless steel-tubing fashioned in a lace design, which has been prepared and makes a very effective display. There is a complete range of the famous "Apollo" tubular box spanners. The ordinary box spanners shown are made to suit Whitworth, B.S.F., B.A., S.A.E., millimetre bolt and other standard-sizes finish.

Bell's United Asbestos Company, Limited, show a complete range of asbestos packings, jointings and lagging materials, including most of their well-known specialities, and their patent "Reefer" H.P. steam packing, non-conducting composition for boilers and pipes. They are also exhibiting a number of interesting specialities in general engineers' requisites, such as the "Victor" patent superheated steam valve, "Gladiator" rod valve-taps, unbreakable pulleys, lubricating oils, motor oils, etc.

John Thomson Water Tube Boilers, Limited, Wolverhampton, are showing their dish-ended boiler, which is built up to 230 lbs. working pressure per square inch. Whilst we have classed this exhibit under "Allied Industries," yet boilers are so important for many foundrymen that they could have been placed under the caption of "Foundry Equipment." Steel chimneys and superheaters are forming an important part of the exhibit.

Messrs. Gibbons Brothers, Limited, Dibdale Works, Dudley. This house is showing water-sealed furnaces for the clean annealing of brass wire, strip and sheets. They are provided with a novel mechanism for driving the conveyor. Their handy furnace-charging machines are well known, and have been described in these columns. As manufacturers of silica and fire bricks, they are well known to the foundry industry.

Messrs. James Dawson & Son, Limited, Lincoln, are showing an extensive range of balata leather and hair belting. They are respectively known as "Lincona," "Dorsona" and "Weltona," and whilst we have put this exhibit under "Allied Trades" they could be classified as "Foundry Requisites."

The Brooke Tool Manufacturing Company, Limited, Warwick Road, Greet, Birmingham, are showing a selection of modern high-speed tools, such as twist drills, reamers, taps and dies.

LICENCES have been granted under the Non-Ferrous Metal Industry Act, 1918, to:—Bowen, Norman Stafford, trading as Thomas Bowen & Son, 22, 23 and 96, Coleshill Street, Birmingham; Bradley, Phillips & Company, 39, Heath Mill Lane, Birmingham; Harris & Son, A., 173, Thimble Mill Lane, Birmingham; Haydock, Molineaux & Company, Limited, Foster's Buildings, High Street, Sheffield; Neems & Company, E. W., 11, Fenchurch Street, London, E.C.3; Tozer, Kemsley & Millbourn, Limited, 84, Fenchurch Street, London, E.C.3.

An Apprenticeship Course in Foundry Practice.—XXXI.

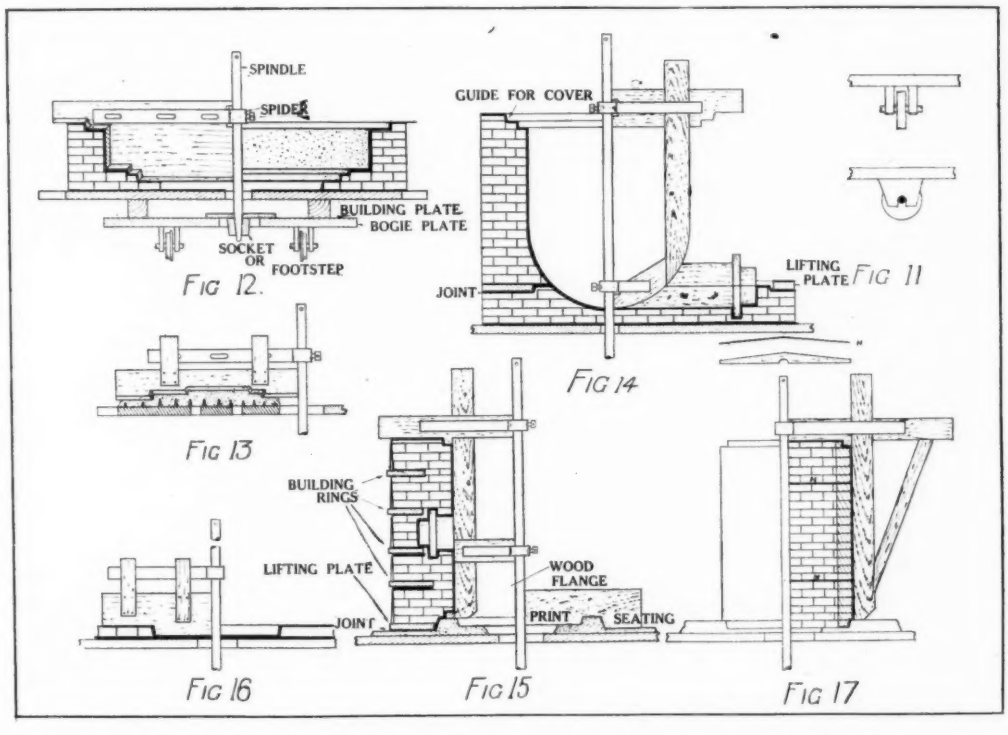
By Ben Shaw and James Edgar.

LOAM MOULDING.

Part III.

Sweeping about a Vertical Spindle.

Castings of a cylindrical character are particularly suitable for sweeping. Either a loam pattern may be swept up, to which subsidiary parts in wood are attached, or a cope may be swept out and subsidiary pattern sections located during the process of building the mould. The method selected depends largely upon the particular shape of the casting required, and also upon the practice usually adopted in any one foundry. Some foundries prefer to sweep the mould direct, while others show a preference for a loam pattern. In the former method the moulds are generally made entirely of bricks and loam, whereas when a loam pattern is prepared, apart from the bottom plate, in and out of a drying stove. The most convenient form of bogie is that which consists of a plate resting upon wheels, as shown in Fig. 11; the plate can then be lifted if necessary, and another more suitable for the work to be done substituted, the same wheels being used. Facilities should be available for conveying the bogies on rails set flush with the floor and stove, or having recesses formed in which the bogie wheel can run. This is particularly necessary for large work when jolting, due to uneven running, is likely to cause injury to the work. Flanged wheels may be used for running on rails, or wheels having flat peripheries can be used for running in prepared grooves. Bogies so prepared need four wheels, but small bogies are more conveniently moved about on three wheels, and with reasonable care and a comparatively level floor these are quite suitable for the smaller work



the mould is frequently made in dry sand. This difference in method is only in evidence when the work to be done can be satisfactorily accomplished either way, but custom together with the tackle and facilities available in a foundry are the deciding factors in favour of one of these methods.

Little or no difference of opinion exists in the method of preparing loam moulds for cylindrical castings of large diameter that are comparatively flat, such as cylinder covers and the like; for these the mould is swept out—that is, it is made direct. Some variance in method is necessary in providing the cover for such moulds, but this is largely governed by the shape of the casting to be made. Thus, in some instances, the cover is swept in an inverted position and turned on to the mould after it has been dried, while in other cases a thickness of sand or loam corresponding to the thickness of metal may be swept on the mould, and on which the cover is prepared.

Tackle.

In order that work in loam can be prepared by means of a profiled-edge board an amount of tackle is necessary varying in character and quantity according to the requirements of the work in hand. With very few exceptions, loam work is prepared on bogies, for greater convenience in conveying it without rails or recesses in the floor to receive them. The bogie plates should be of substantial thickness to support any work likely to be built upon them.

Building Plates.

Rarely is work built directly upon the bogie plate, but it supports another plate known as the building plate, and this plate also needs to be strong, in order that it will support the work upon it. Frequently loam work is lifted from the bogie for casting purpose, and the building or foundation plate must carry the weight. Lugs are cast on these plates, to take the crane slings for lifting. Strength is also necessary to resist any pressure during the time of casting. Holes are cast in building plates sometimes for lightening purposes, but more frequently with a view to providing facilities for providing bottom vents, if the plate should be used for casting upon. Bottom vents are not always needed, but when the plate is so made, its utility is increased. As a rule, short gaggers are cast on the upper surface of building plates, to hold the loam applied to them.

Supporting Spindles.

Spindles for vertical sweeping are supported in a number of ways. Sometimes they are centred

in a top and bottom plate, the top plate being secured to a bracket, which is secured to a column or to a wall, or the bracket may carry a collar or sleeve encircling the spindle. In both cases the spindle revolves with the board. Sometimes the spindle is secured and made a temporary fixture, in which case the board is made to revolve about it. When the work to be swept is not more than about 6 ft. high, it is not essential that it should be supported by means of a bracket; if one end is given a long taper, and it is made to fit accurately into a centre plate, socket, or footstep, it will remain in a vertical position while being revolved, providing the diameter is not too small. The spindle should be machined parallel, and be anything from 2 in. to 4 in. in diameter, according to the height and size of the work to be done. A $\frac{3}{4}$-in. or $\frac{7}{8}$-in. hole should be drilled through the top for convenience in lifting the spindle after the sweeping has been accomplished. Spiders or tail-pieces fitting the spindle are used for fixing the sweeping boards. When the spindle is a fixture, then the spider must revolve about it, and a fixed collar is necessary to support it at the required height, but when the spindle revolves, then the spider should be fixed to it. A stud, having a hole drilled through the head, is handier in the foundry; the tang of a file, or any bit of iron that will enter the hole, can be used as a tommy bar, and this is preferable to a spanner. Slot holes cut through the spider are convenient for bolting the boards in position, a method that is superior to clamping them. The general arrangement of tackle suitable for sweeping the mould for the large centralising disc casting, the sketch for which appeared in Article No. 30, is shown in Fig. 12.

Sweeping Moulds.

Large shallow moulds do not need to be lifted from their foundation plates, therefore it is not necessary to prepare a seating or guide, and the print in any case can be swept with the mould at one operation. Ring plates are also unnecessary if the depth of the work is not more than 12 in. or 14 in., but external gaggers should be used unless it is intended to ram sand about the outside of the brickwork in a suitable pit before casting, in order to give the brickwork support to withstand the pressure of the molten metal. As a rule, the brickwork is built up first, the bricks being laid about $\frac{3}{4}$ in. clear of the board, which is rotated during the process of building. The bricks should not be too close together, the loam between them being not less than $\frac{1}{2}$ in. thick, and usually more. Ashes are frequently used towards the outside of a mould to release gases more readily that are generated when casting, and thus free the surface pressure. When the brickwork has been built up to within about 1 in. of the top, facing loam can be applied to the inside, and the board rotated to define the shape. The first application to the inside of the bricks should be wiped on with the fingers, a process which is generally done while building. This is necessary to cause the loam to adhere firmly and prevent it being lifted by the board when sweeping. When the shape has been defined, an application of very thin loam is made, and the board again rotated to give a better surface.

Any subsidiary pattern sections representing external parts on the required casting, not capable of being swept, must be introduced in their respective places during the time of building, and the bricks must be kept clear for this purpose. An example of shallow sweeping is shown in Fig. 12. It will be noted that a guide is formed on the top to locate the cover, but in order that the joint of the mould can be checked when assembled, the guide is cut away in a few places. Covers that are swept separately should be as flat as possible, because bricks cannot be so conveniently used unless they are bolted or otherwise secured to the plate on which the shape is swept. Thus, the cover for the centralising disc, shown in Fig. 13, is swept on short gaggers cast with the plate.

In making loam moulds for cylindrical castings that are high as well as being large in diameter, it is frequently necessary to lift the cope from the bottom plate. This is often done even when it is not essential, for greater convenience in preparing the mould after it has been dried, and also because many moulders prefer to lower the cope over the core rather than to introduce the main core into the mould, even when either method is possible. This is due to the fact that the joint or seating for the cope is usually visible from the outside, and the bottom of the mould, too, can be seen until the cope registers on the seating; thus, should any injury be done to subsidiary projecting cores, it is more likely to be observed when the cope is lowered over the main core. Two examples of sweeping boards of this character are illustrated in Figs. 14 and 15. The former represents the method suitable for a suction chamber. The spherical end is moulded down, and a joint is necessary for withdrawing the branch pattern and for introducing its core. A strip of wood, shaped to form a seating or guide, is temporarily attached to the main sweeping board, so that it will form a bearance coinciding with the joint of the branch pattern.

Building Up Seatings.

In building the seating it is necessary that the building plate be large enough to encircle the brickwork about the branch, and give sufficient bearance for the joint plate to carry the cope. When the seating has been swept, the bottom half flange can be located and the seating continued about it. The loam is usually allowed to stiffen at a joint before proceeding with the work, the joint being then dusted with parting sand and a thickness of loam applied, into which the joint plate is bedded. The cope is built on the joint-plate in the same manner as previously explained, and when the mould is to be eased in and sand rammed about it, building rings are not essential.

The other illustration, Fig. 15, represents the method of sweeping a cylindrical mould when the centre core is parallel and cuts through each end of the casting. It is in such cases as these that the cope is usually made to separate from the bottom plate, and for this purpose the first sweeping to be done is the making of the seating and print, and this forms a bearance on which the cope is built. The method is clearly indicated in Fig. 15. It will be noted that building rings are introduced during the process of building, and gaggers are cast with them to enclose the brickwork.

Loam Patterns.

Loam is advantageously employed for making patterns, and many are prepared about a vertical spindle by means of sweeping boards. In many foundries a loam mould is rarely made if a loam pattern to be used in sand is possible. In such cases the brickwork need not be so substantial as for a mould, as the pattern only needs sufficient strength to resist the ramming of sand about it. Loam patterns or "dummies" that are to be used in the same manner as a wood pattern in the formation of a dry-sand mould do not need to have an external guide or seating on the bottom plate, but the plate on which it is built forms part of the mould, and therefore a print must be swept out to receive the centre core.

Thus, in the formation of a loam pattern for the cylindrical casting previously referred to, the bottom plate would be prepared in the manner shown in Fig. 16, and this part forms the bottom of the mould subsequently. In sweeping the pattern, owing to the height of the job and the fact that only one spider can be used, gauge irons should be introduced in the brickwork to form a check on the diameter of the work during the time of sweeping. The length of the gauge irons is determined from the gauge stick supplied, and they should be bent to clear the spindle, as indicated by H in Fig. 17. No recess in the pattern is necessary to receive the wood flange at the bottom, as the segmental pieces supplied should be used to rest on the bottom bearance and against the dummy pattern.

When wood flanges are supplied for other parts, a recess should be formed about the pattern to receive them; thus in Fig. 17 it will be noted that a recess is formed at the top to support a wood flange. The wood patternwork for branches or other pattern sections are secured to the loam pattern after it has been dried, and been located in a suitable case preparatory to commencing the mould. Loam patterns of this type are not stripped from their moulds in the same manner as wood patterns, but are broken and removed brick by brick. *(To be continued.)*

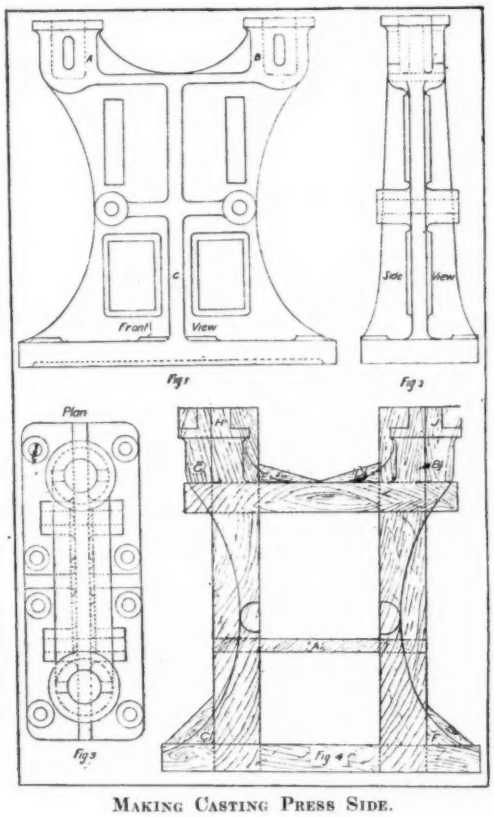
The Making of a Casting-Press Side.

By V. DEWHURST.

The object of this article is to outline a method of making a pattern for a casting-press side which will reduce the time taken in moulding.

Figs. 1, 2 and 3 gives three views of the side of a casting-press machine casting, three of which are required to make one set. The middle one is shown, the two end ones are different, the pattern for the middle one having the facings removed from one side to produce them.

The first consideration before proceeding with the making of the pattern is, whether the moulder proposes to make it in boxes or bedded in the floor. Its size, 5 ft. by 4 ft., at once suggests the latter. This means that having dug a hole out, and laid the pattern in the bottom, the moulder must be able to get to the underside of the pattern in order that the bosses and ribs shall be rammed firmly; the plate or body of the pattern must therefore be framed up, making the spaces in the



MAKING CASTING PRESS SIDE.

framing as large as possible for this purpose, leaving only sufficient timber to carry the bosses and facings as required. Fig. 4 shows how this is done, the main joints being half-lapped. The two sides are made short from the bottom, equal to the thickness of the facing strips on the bottom, but extended on the top sufficiently far to carry the prints for coring-out the two bosses, as shown at H and J (Fig. 4). Where the outline of the job extends beyond the lines of the framing as at present suggested, separate pieces would be added after as B, C, D, E, F, and G, as indicated in Fig. 4.

A supporting-bar is shown at A (Fig. 4), for the square-strip-facings, which also help to secure the main centre rib, shown at C (Fig. 1).

After face-trimming the frame and marking on it all lines for further parts, and finishing the outline to shape, details would next be made. Cross-rib bosses would be arranged to half-lap with an upright centre rib, Fig. 1.

The two bosses A and B, Fig. 1, and their core prints with a thicknessing strip equal to the thickness of the frame, would be turned in the lathe. This piece being afterwards taken out, the remaining portions would be placed on the two sides where required.

Prints for the cotter holes in bosses are fixed on both sides, *i.e.*, the top and bottom of the pattern. The facing strips on the bottom flange are fastened on pattern with the lower piece made to work loose, and would make up the required length of the casting.

The plate-facings and the two ordinary round prints for the bosses in the middle of the pattern are then fixed on the under side or the bottom of the pattern and it is complete.

A half core-box for the cotter holes is supplied, as by making these in halves vent-making is facilitated, and they are easier turned out of the box, having a flat side to lay on the core-plate for drying.

It is important to note that all those parts of the pattern which would be in the bottom part of the mould should be so fastened by screws through the body plate that when the moulder takes out the screws, the details, *i.e.*, the ribs, bosses, etc., will be left in the sand. The opposite side of the pattern, *i.e.*, top part of mould, has all details pegged or dowelled on the body plate. These details will come up with the mould when top box is lifted off, and their easy withdrawal on rolling over the top box and, in the case of bottom mould, after drawing the pattern plate, will greatly reduce the time taken to finish the mould.

Swedish Iron and Steel Trade, 1922.

The Annual Report of the Swedish Ironmasters' Association states that the year 1922 has been a very difficult one for the Swedish iron and steel industry, although on the whole it compared favourably with 1921. There were on December 31 only 32 blast furnaces working out of a total of 130 (against 22 on December 31, 1921); out of 204 Lancashire hearths 53 were in operation (37 in 1921), 3 Bessemer converters out of 18 (compared with 5 the previous year), and 24 open-hearth furnaces out of 82 (against 15 a year ago). Towards the end of the year the demand for iron and steel decreased, and during December 4 blast furnaces, 12 hearths, 7 Bessemer converters and 11 open-hearth furnaces were stopped.

The total output during 1922 amounted to 259,700 metric tons of pig-iron (about 35.5 per cent. of the 1913 production), against 314,000 tons in 1921; the output of steel in 1922 was 342,900 tons of ingots, etc. (46.1 per cent. of the 1913 production), compared with 236,000 tons in 1921; and the output of rolled and forged iron and steel was 212,700 tons (corresponding to 61.5 per cent. of the 1913 figure), compared with 127,200 tons in 1921.

The exports of iron and steel in 1922 included the following items in metric tons (the figures for 1921 being shown in brackets for comparison):—Pig-iron, 20,700 (10,900); tinplate, 7,300 (3,300); cast pipes, 15,300 (6,800); wrought iron and steel tubes, 12,200 (6,600); rails, 26,600 (42,400); plates and sheets, 14,300 (24,300); other rolled iron and steel, 41,900 (33,700).

The following table shows, in metric tons, the Swedish imports and exports of iron and steel during the last quarter of 1922 and the whole of the year compared with the same periods of 1921:—

	Last qr. 1921	Last qr. 1922	Year 1921	Year 1922
Imports ..	21,300	47,900	129,500	139,700
Exports ..	46,400	49,300	147,600	174,300
Exports— (iron ore)	—	—	4,333,000	5,324,000

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, have taken an order for turbo-generating plant of a capacity of 50,000 k.w. for Japan.

THE SKINNINGROVE IRON COMPANY, LIMITED, are to restart their Boulby (North Yorkshire) ironstone mines next Monday, whilst Sir B. Samuelson & Company, Limited, have just restarted their Guisborough (North Yorkshire) ironstone mines. Over 400 men have just restarted at the latter mines, which have been closed down for two years.

Trade Talk.

MR. W. L. HOLLAND, engineer and brass founder, of 141, Adelphi Street, Preston, has established a new brass foundry in Milton Street.

THE EAGLE ENGINEERING COMPANY, LIMITED, Wallace Street, Warwick, have taken over the business carried on by Champ, Kay & Company, of Warwick.

A. J. CROFT AND COMPANY, LIMITED, non-ferrous metal manufacturers, formerly of Holly Lane, Perry Barr, have removed to 150, Alma Street, Aston, Birmingham.

HEENAN AND FROUDE, LIMITED, engineers, of Worcester have removed their London office from 150, New Bond Street, W.1, to Blackfriars House, New Bridge Street, E.C.4.

CAMMELL, LAIRD & COMPANY, LIMITED, Birkenhead, have placed an order with John Cochrane, Barrhead, Limited, for all the main iron castings for the battleship "Rodney."

WM. CROCKETT & SON, LIMITED, have just appointed the Liverpool Patents Company, Limited, County Chambers, Corporation Street, Birmingham, as their Birmingham and district agents.

THE RUNBAKEN MAGNETO COMPANY, LIMITED, of Manchester, have established a branch at 17, Clare Street, Dublin, with Mr. W. E. Martlew, formerly of the Birmingham branch, in charge.

ONE OF THE blast furnaces at the Seaton Carew Ironworks is being closed down owing to the shortage of coke; and in the meantime certain repairs will be effected. Two furnaces will be left in operation.

HENRY BATH & SON, LIMITED, metal merchants, London, Swansea and Liverpool, have established a branch in Birmingham at Worcester Chambers, 105, Colmore Row, under the management of Mr. R. H. Lloyd.

THE MEMBERS of the Institute of Marine Engineers met at the Institute Premises, The Minories, Tower Hill, London, E.C., on February 13, to hear a paper on "Internal Combustion and Economy," by Mr. Tage D. Madsen.

THE SKINNINGROVE IRON COMPANY, LIMITED, have restarted their Boulby (North Yorkshire) ironstone mines, whilst Sir B. Samuelson & Company, Limited, have just reopened their Guisbrough (North Yorkshire) ironstone mines.

RUBERY, OWEN & COMPANY, structural engineers, of Darlaston, have established offices in London at 36-38, Kingsway, W.C.2, and at 1, Queen's Road, Coventry, under the management of Mr. H. J. Searle and Mr. G. H. Smart respectively.

MR. G. H. MURIEL, who is leaving Whitehaven to take over the position of secretary to the North Lonsdale Iron and Steel Company, Limited, at Ulverston, has been the recipient of a handsome presentation from friends at Whitehaven.

THE ROWARTH ATKINS STEEL WORKS COMPANY have established themselves in business at Trent Street, Attercliffe, Sheffield. The works will be under the direction of Mr. Rowarth Atkins, lately with William Atkins and Company, Limited.

GOODBRAND & COMPANY, LIMITED, Britannia Foundry, Stalybridge; the Derwent Foundry Company (1920). Limited, Exeter Place, Derby, and Day, Summers & Company, Northam Ironworks, Southampton, have joined the Federation of British Industries.

THE BRITISH REINFORCED CONCRETE ENGINEERING COMPANY, LIMITED, have removed their branch office at Leeds to 5, East Parade, Leeds. At this address Mr. McLean Gibson is in charge of the constructional department, and Mr. J. W. Liversedge the roads department.

ABBOTT AND HAWKINS, of 50, Charles Street, Cardiff, have been appointed agents in South Africa for Mawdsley's, Limited, electrical engineers, of Dursley, Gloucestershire, while Mr. Horsburgh, 217, Coles Lane, Sutton Coldfield, Birmingham, has been appointed representative in the Midlands.

MODERN DEVELOPMENTS IN the design of reheating and open-hearth furnaces were dealt with by Mr. R. J. Sargant, in a lecture on "Flame and Flame Furnaces," which he delivered before the Sheffield Association of Metallurgists and Metallurgical Chemists, at the Royal Victoria Hotel. Mr. B. Methley presided.

A JOINT dinner of the members of the Newcastle Chamber of Commerce, the North of England Steamship Owners' Association, the Newcastle Shipbrokers' Association and the North-East Coast Coal Exporters' Association, is to be held on Friday evening, March 2, at the old Assembly Rooms, Westgate Road, Newcastle. The principal speaker will be Mr. Arthur Balfour of Arthur Balfour & Company, Sheffield. Lord Joicey will preside at the dinner.

THE LATE MR. F. J. MAIE, of Gateshead, Durham, for many years manager for T. Proctor & Son, iron and steel merchants, left £7,376.

Company News.

Saxton & Company, Limited.—Capital £3,000. Iron and metals merchants. Permanent governing director: A. H. Saxton.

Wilson's Foundry, Limited, Halifax.—Capital £3,000. Directors: T. L. Wilson, J. P. Wilson, and Miss A. Bottomley.

Norbury Engineering Company, Limited, Borough Foundry, Great Norbury Street, Hyde, Cheshire.—Capital £1,000. Directors: J. Arstall, A. Morley, F. Morley and L. Day.

Tom Dawson & Company (Metal Brokers), Limited, 161, Thornton Road, Bradford.—Capital £3,000 in £1 shares (250 preference and 2,750 ordinary). Managing director: W. E. Errington.

Mather & Platt, Limited.—Final ordinary dividend, 7 per cent., making 10 per cent., free of tax, for year; additional tax-free bonus, 5 per cent., placing £200,000 to the reserve; carried forward, £174,953.

John W. Thompson, Limited, Allenby Works, 23, Spring Street, Sheffield.—Capital £10,000 in £1 shares (5,000 7½ per cent. cumulative preference). Railway fitting manufacturers. Directors: J. W. Thompson and S. Bendall.

Windsor Bowen Syndicate, Limited, 7-8, Norfolk Street, London, W.C.2.—Capital £1,007. Civil, mechanical, electrical and general engineers, etc. Directors: Lt.-Col. W. H. F. Basevi, E. Windsor Bowen and C. E. Haines.

The Cleveland Shipbuilding Company, Limited, Cleveland Dockyard, Middlesbrough.—Capital £200,000 in £1 shares, to adopt agreements (1) between A. M. Ingledew and A. D. Greatrex, of the first part, William Harkness & Company, Limited, of the second part, and the Hon Sir Charles A. Parsons of the third part; and (2) between Sir Raylton Dixon and Company, Limited, and W. J. Temple, of the one part, and the said Hon. Sir Charles A. Parsons, of the other part. Directors: The Hon. Sir Charles A. Parsons, K.C.B. (chairman), S. F. Prest, C. J. Leyland, and R. J. Walker.

Gazette.

THE WEBB ENGINEERING COMPANY, LIMITED, are being wound up voluntarily. Mr. A. Shankland, 82, Queen Street, Cardiff, has been appointed liquidator.

HEAVY STAMPINGS, LIMITED, have decided to wind up their affairs by voluntary liquidation. Mr. J. H. Anderson, Zetland Road, Middlesbrough, has been appointed liquidator.

MESSRS. E. HASLEM, W. Womersley and F. E. Womersley, ironfounders, Waterside, Halifax, trading under the style of Womersley Bros. & Holt, have dissolved partnership.

THE PARTNERSHIP heretofore subsisting between Messrs. J. S. Phelps and W. H. Bluck, engineers, Hatherton Street, Walsall, under the style of Phelps & Bluck, has been dissolved.

MESSRS. J. WILSON and J. Wilson, ironfounders, Parkinson Street, Mill Hill, Blackburn, trading under the style of Wilson Bros., have dissolved partnership. Mr. J. Wilson continues in his own name.

MESSRS. S. W. ABBOTT and W. J. M. Hawkins, trading under the style of Abbott & Hawkins, 50, Charles Street, Cardiff, electrical and mechanical engineers, have dissolved partnership. Mr. S. W. Abbot continues.

MESSRS. A. E. DOWNING, E. Holden and J. Loach, brassfounders, drop forgers and engineers, Spon Lane and Chapel Street, West Bromwich, trading under the style of A. E. Downing & Company, have dissolved partnership, so far as concerns Mr. E. Holden, who retires.

THE NAMES of the undermentioned companies have been struck off the Register of Joint Stock Companies, and such companies are dissolved:—Boardman Electrical Patents Company, Limited; British Pneumatic Tool Company, Limited (registered February 8, 1910); Central Zinc Company, Limited; Frost Patent Engine Syndicate, Limited; Northern Victoria Foundry Construction Company, Limited; Victoria Foundry and Engineering Company, Limited, and the West of Scotland Copper Company, Limited

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CAPTAIN O. LYTTLETON has been appointed general manager for the British Metal Corporation, Limited, Abchurch Yard, London, E.C.

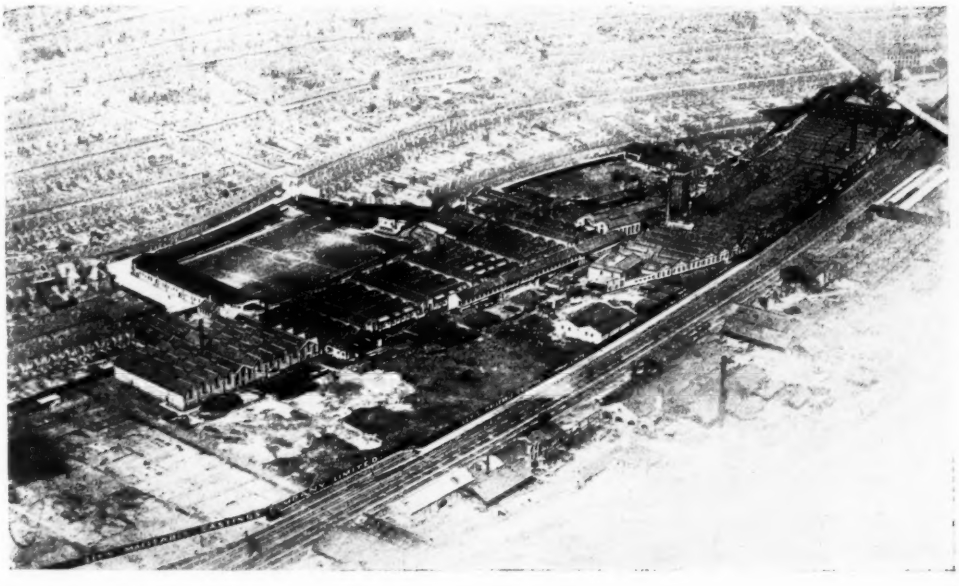
MR. A. REYNOLDS has now joined the roads department of the British Reinforced Concrete Engineering Company, Limited, 4, Iddesleigh House, Caxton Street, Westminster, London, S.W.1.

"BLACK HEART"

(REGD. TRADE MARK.)

MALLEABLE CASTINGS

The WORKS.



The above is an aerial photograph of the Works which cover 30 acres.

The PRODUCT.

The above is a full size photograph of a Test Piece bent cold from the flat.

ALL ENQUIRIES TO :

LEY'S MALLEABLE CASTINGS Co., Ltd.

Vulcan Ironworks - - - - DERBY

Telephone Nos. 896 & 897. Telegrams : LEY'S, DERBY.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron trade during the week have taken a quieter turn, although it cannot be said that demand has in any degree diminished, the explanation being that there is very little iron of any description now available for this month's supplies, with every prospect that March deliveries will be equally difficult. Business, consequently, has been again reduced to almost hand-to-mouth proportions, the upward trend of price movements checking the expansion of buying essential to any permanent improvement in trade. A further disturbing element as affecting export trade from North-East Coast ports is the political situation on the Continent, both French and German pig-iron purchases being restricted by the uncertainty. American buying has also been checked for the time being, while the broadening out of trade generally, of which there seemed fair promise at the opening of the year, has been interrupted, and a new set of complications introduced, the ultimate end of which it is impossible to forecast. In the meantime the position as regards Cleveland iron becomes more stringent, for though the demand is not heavy relatively to a normal standard, it is greater than the output. Hence such small lots of prompt No. 3 iron as are obtainable for February shipment are at a minimum of 115s., and this is also a seller's quotation for March/April. A lower figure might possibly be done farther forward, but the forward position is entirely neglected at the moment. With No. 3 at 115s., and the other qualities all equally scarce, prices are more or less nominal. No. 1 would, statistically, be 117s. 6d., but it is unobtainable. For No. 4 foundry 110s. is named, and No. 4 forge is anything near to 100s., and silicious round about 115s.

Increasing strength is the dominant note of the hematite position. Makers are sold out for February, and mixed numbers for March/April are now at a minimum of 110s. per ton. A substantial cargo has just been sold to Germany at this figure, and several orders to the United States have also been effected. On the whole, export business with the Continent is rather better, though the trade tends to be very spasmodic. The home demand is steady and improving. One hematite furnace on the North-East Coast has just gone out, but it is to be replaced shortly by another at the same works. Meanwhile, the total number of furnaces in blast on the North-East Coast is reduced to 39, of which 12 are on Cleveland, 14 on hematite, and 13 on basic and special kinds of iron. On the North-West Coast rising costs have compelled ironmasters, however reluctant they may be to do so, to raise prices, but there was a further advance last week, Bessemer mixed numbers being quoted at £6 per ton delivered at Glasgow and Sheffield, £6 2s. 6d. per ton for export, £6 5s. per ton delivered at Birmingham, and round £6 5s. at South Wales.

MANCHESTER.—Movements in the local market for pig-iron have been on a more restricted scale of late, consumers of foundry qualities complaining that the higher prices ruling have had an adverse effect upon business. Derbyshire, Lincolnshire and Northamptonshire foundry irons are now quoted at about £4 18s 6d. to £5 1s. 6d. per ton delivered in Manchester. Of Lincolnshire very little, if any, is now being offered. Makers of Scotch foundry iron have advanced their prices slightly, and sellers in Manchester now usually quote £6 3s. 6d. per ton delivered for No. 3, although perhaps it might still be possible to buy at £6 2s. 6d. East Coast hematite iron has been advanced, and it now costs about the same in Manchester as Scotch No. 3. Some of the Manchester ironfounders have been using it instead of Scotch, but that was when it could be bought at 10s. less. Whether they will continue to use it when the price is the same as that for Scotch remains to be seen.

THE MIDLANDS.—Demand in this district is well sustained, and would in normal times undoubtedly stimulate increased furnace production, but any development in this direction is regarded by ironmasters as now out of the question while fuel supplies remain at present exorbitant rates. As a consequence there is very little iron available for prompt deliveries, and sellers are mostly off the market. The position is not any easier as far as contracting is concerned. There appears to be quite a considerable inquiry for iron for delivery in the second quarter of the year, but smelters are not anxious to contract forward until the outlook is distinctly clearer. In some cases they are "off the market" altogether and decline to quote. In others the quotation suggested is deliberately intended to be prohibitive, because smelters are not yet ready to sell any farther forward.

SCOTLAND.—Buying in the market for Scotch pig-iron during the past week has developed a quieter tendency, but demand on the whole is well maintained, with sufficient strength to justify makers putting additional furnaces in blast. Owing to the scarcity of both Middlesbrough and Continental iron buyers are finding great differences in prices for any iron available. Cleveland No. 3 has been done at Glasgow at over £6 delivered Clyde ports, whilst Continental has been offered at prices ranging from £5 2s. 6d. to £5 10s. delivered. No. 3 Scotch can be got at £5 6s. 6d. delivered, and a little more forward business has been done at this price. Export inquiry continues good, but there has been no renewal of buying from the United States, eastern seaboard, although inquiries are in the market for the Pacific. The prices of No. 1 and No. 3 Scotch f.a.s. Glasgow are £5 15s. and £5 10s. per ton respectively.

Finished Iron.

Markets for most classes of finished material maintain steady activity, the bar mills being well employed, and constructional and engineering works reporting a fair share of business in hand, with an encouraging volume of inquiries under consideration. Makers of lower grade bars have been greatly helped by the Continental complications, which have considerably reduced the imports of these qualities. To a great extent they have the market to themselves and are able to secure a minimum of £10 10s. for nut and bolt qualities. The price of crown iron is also very firm. There is now no difficulty in selling at £11 10s., and good sales have been made. The chief anxiety at the moment is the price of pig-iron. That going into consumption was fairly well bought, but it is very difficult to cover any farther ahead; at any rate, at a price which seems reasonable and which will not force bars beyond a level which at present the market seems capable of supplying. Some ironmasters profess to be rather concerned about it; to fear that high prices may put an end to the expansion of demand that hitherto has seemed so encouraging. Most ironfounders are also realising the advantage of fuller activity in the manufacturing and engineering departments of the industry, but makers of builder's cast-iron work are still awaiting the flow of fresh business that should materialise when housing schemes, now in abeyance, can be put into actual operation.

Steel.

Accepting as an accurate guide to conditions in the steel industry the current of business in the ferro-alloy market there can be little doubt that the revival of demand both for home and abroad is progressing with steady persistence, though here and there varying in degree. The railway material manufacturing firms are all very busy, and with further announcements of heavy buying in such material, business in this direction is undoubtedly developing into a small boom. This, coupled with the diversion of steel orders from the Continent to this country, is responsible for most of the larger alloys orders placed recently. Some Continental inquiry is reported for ferro-manganese, ferro-silicon, and the like, but not to the same extent as last year. In the home markets the shortage in manganese ore and the continued demand for ferro-manganese is strengthening the market, and a price appreciation would, in consequence, cause little surprise. It is to be hoped, however, that prices of this or any other largely used alloy as well as other raw materials will not jump too high and so kill trade once again at a time when careful nursing is so necessary. Ferro-manganese prices remain unchanged at the moment for either home or export, and makers appear to be well booked. Spiegel also shares in the demand, with prices firmly maintained. Several inquiries for both 45 per cent. and 75 per cent. ferro-silicon are noted for domestic consumption as well as for export, while orders for 100 tons, and several smaller lots of 45 per cent. grade have recently been placed. In 75 per cent., one or two orders for fair quantities have been booked, and interest seems to be reviving in this grade. In the market for semi-products the strong demand which has been in evidence of late for tin bars has culminated in a further advance in the minimum price, which is now £8 6s., less the rebate of 7s. 6d. The majority of the works are well booked, and the activity of the tinplate trade has been a factor. A

(*Continued on page* 17.)

IRON AND STEEL MARKETS,—*Continued.*

firm and active market continues for tinplates, although the volume of business may not be quite so large as in recent weeks. The committee, however, have decided to raise the minimum price to 21s. per standard box. This figure has, of course, already been exceeded, and there are few, if any, sellers at that price, unless it happens to be a merchant who bought speculatively some time ago. Some of these have been under-cutting the makers for weeks past. Wasters are in good inquiry, and lights, which are scarce, are wanted for the East.

Scrap.

The improvement previously noted in the various markets for scrap metal continues unabated, the prevailing shortage and enhanced prices of pig-iron contributing largely to the growing demand for substitute materials. In Lancashire the prices for cast-iron scrap are advancing, and it is reported that in some districts up to £5 per ton has been paid for good broken machinery cast-iron. This is, however, not the case all over the country. Prices for this kind of scrap vary a good deal in various parts. In Wales, from 85s. to 90s. is paid, but 90s. is there considered a top price. The finest lots of textile machinery scrap in the Lancashire district, may, perhaps, bring 95s., but founders are not paying this yet for ordinary cast-scrap. On the North-East Coast the demand for heavy steel scrap is particularly keen, and would be taken in almost any quantity at about 85s. per ton. For good heavy machinery quality cast-iron scrap in handy pieces 90s. is being freely paid, and the price continues to advance. Heavy steel turnings and cast-iron borings are realising round about 67s. 6d. per ton, and upwards of 85s. per ton is being paid for good heavy wrought-iron piling scrap. Specially selected heavy forge is quoted up to 100s. per ton. All these prices include delivery at works.

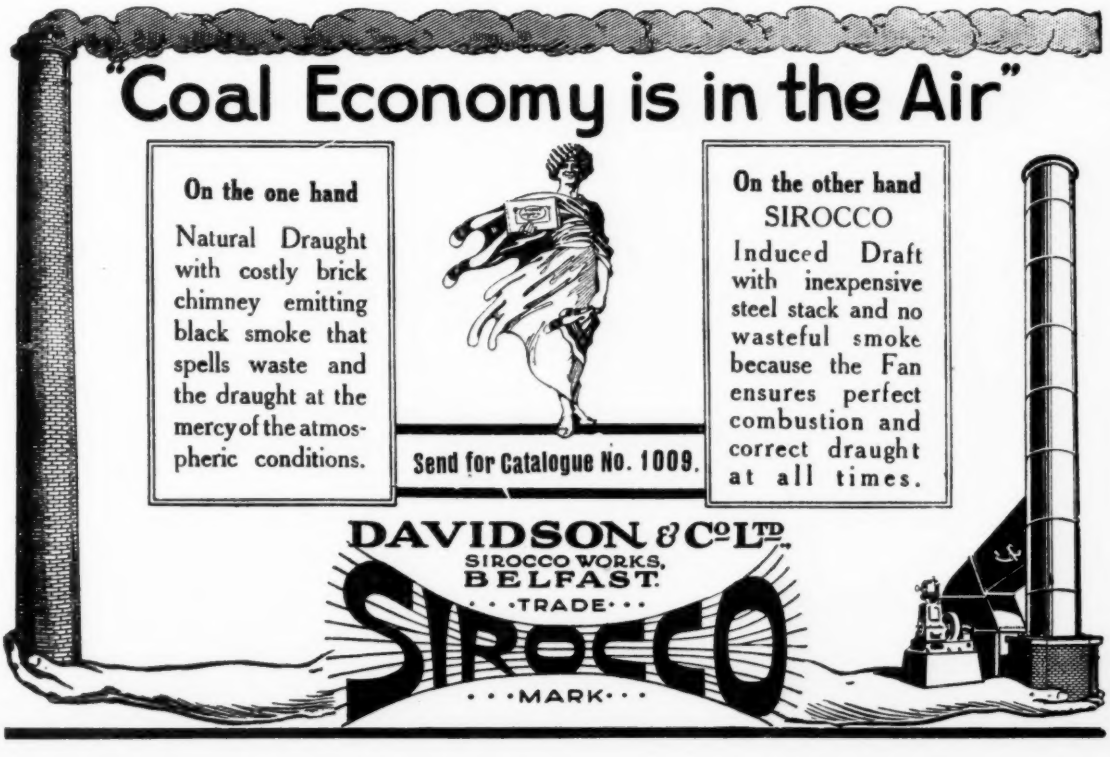
Metals.

Copper.—Values of standard copper are again on the up grade, and it is reported that there has been heavy buying on German account of late, though in the existing conditions in the manufacturing industries of that country it is difficult to credit the information. At home there have been fair quantities of metal secured by cable makers, while the state of general consumptive trade demand is also improving. The strength of the market over here is attributable in no small degree to the fact that large quantities of copper are being taken by domestic consumers in the United States. It appears therefore that, although prices are not likely to recede to any considerable extent in the immediate future, consumers would be well advised to view the market with a fair amount of caution. Current quotations :—*Cash* : Wednesday, £66 5s.; Thursday, £66 12s. 6d.; Friday, £67 15s.; Monday, £68 17s. 6d.; Tuesday, £69. *Three Months* : Wednesday, £67; Thursday, £67 7s. 6d.; Friday, £68 10s.; Monday, £69 12s. 6d.; Tuesday, £69 15s.

Tin.—Business in this section of the metal markets during the current week has developed rather more activity and fairly substantial turnovers have been returned. Buying on the whole, however, has been largely confined to the speculative element, although it is admitted that consumptive demand is now on a fairly large scale. America has been a buyer of fair quantities throughout the past week, and the general opinion is that her requirements in the future will be on a much larger scale, as it is reported that stocks in that country are of comparatively small dimensions, while the consuming industries are busy. Current quotations :—*Cash* : Wednesday, £186 7s. 6d.; Thursday, £187 10s.; Friday, £191; Monday, £193; Tuesday, £191 10s. *Three Months* : Wednesday, £188 5s.; Thursday, £189 7s. 6d.; Friday, £193; Monday, £194 17s. 6d.; Tuesday, £193 10s.

Spelter.—The market for this metal continues to develop firmness, and business on the whole has been fairly active. Messrs. Rudolf Wolff & Company state that there have been small inquiries from consumers, but they seem generally to be well covered, and unless they come in as bigger buyers it is likely that prices will drop. After a period of depression there has been a better inquiry recently for zinc sheets; if sales of this commodity fall off the price of spelter will doubtless be affected, as it will mean that producers will have to dispose of their surplus stock of spelter to the galvanising and brass trades. Current quotations:—*Ordinary* : Wednesday, £35 5s.; Thursday, £35 2s. 6d.; Friday, £35 12s. 6d.; Monday, £35 15s.; Tuesday, £36.

Lead.—Values of soft foreign pig fully maintain the firmness previously reported, with, if anything, a tendency to further advance. The demand from home consumers continues on a fair scale, although the general disposition to cover only immediate needs is still in evidence owing to the high prices. Current quotations:—*Soft foreign (prompt)* : Wednesday, £28 7s. 6d.; Thursday, £28 5s.; Friday, £28 5s.; Monday, £28 5s.; Tuesday, £28 7s. 6d.


"Coal Economy is in the Air"
On the one hand
Natural Draught with costly brick chimney emitting black smoke that spells waste and the draught at the mercy of the atmospheric conditions.
Send for Catalogue No. 1009.
On the other hand
SIROCCO
Induced Draft with inexpensive steel stack and no wasteful smoke because the Fan ensures perfect combustion and correct draught at all times.
DAVIDSON & Co LTD.
SIROCCO WORKS,
BELFAST.
TRADE
SIROCCO
MARK

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	60 0 0
Three months	69 15 0
Electrolytic	76 0 0
Tough	72 10 0
Best selected	72 10 0
Sheets	100 0 0
India	85 0 0
Wire bars	76 0 0
Do. Feb.	76 0 0
Do. Mar.	76 0 0
Ingot bars	76 0 0
H.C. wire rods	80 10 0
Off. aver., cash, Jan.	64 11 1 7/11
Do. 3 mths., Jan.	65 3 9
Do. Settlement Jan.	64 11 0 3/11
Do. Electro, Jan.	71 10 10 10/11
Do. B.S., Jan.	69 2 2 2/3
Aver. spot price, copper, Jan.	64 9 10½
Do. Electro, Jan.	73 13 7½
Solid drawn tubes	13¾d.
Brazed tubes	13¾d.
Wire	10¾d.
Yellow metal rods	7d.
Do. 4x4 Squares	8½d.
Do. 4x3 Sheets	9½d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	13½d.
Rods, drawn	10⅝d.
Rods, extruded or rolled	6¾d.
Sheets to 10 w.g.	10¼d.
Wire	10½d.
Rolled metal	9¾d.

TIN.

	£ s. d.
Standard cash	191 10 0
Three months	193 10 0
English	191 10 0
Bars	192 10 0
Chinese	189 10 0
Straits	198 0 0
Australian	193 10 0
Eastern	200 15 0
Banca	193 10 0
Off. aver., cash, Jan.	181 18 6 21/32
Do. 3 mths., Jan.	183 9 5 19/32
Do. Sttlment, Jan.	181 18 4 10/11
Aver., spot, Jan.	181 17 0½

SPELTER.

	£ s. d.
Ordinary	36 0 0
Remelted	33 10 0
Hard	28 5 0
Electro 99.9	43 0 0
English	37 10 0
India	29 5 0
Prime Western	37 10 0
Zinc dust	49 10 0
Zinc ashes	13 10 0
Off. aver., Jan.	34 16 8 25/44
Aver., spot, Jan.	35 14 8

LEAD.

	£ s. d.
Soft foreign ppt	28 7 6
English	29 10 0
Off. average, Jan.	26 18 6 5/11
Average, spot, Jan. 27	2 4½

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	44 0 0
Do. V.M. ex whf.	42 0 0
Dutch	42 0 0
Rods	49 0 0
Boiler plates	41 0 0
Battery plates	42 0 0

ANTIMONY.

	£ s. d.
English regulus	27 10 0
Special brands	33 10 0
Chinese	24 15 0
Crude	18 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	10 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£12 0 0
75%	£19 10 0
Ferro-vanadium—	
35/40%	17/- lb. va.
Ferro-molybdenum—	
70/75% c. free	9/- lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/1 lb.
Ferro-phosphorus, 20/23%,	£23
Ferro-tungsten—	
80/85%, carbon free	1/5 lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
4/6% car.	£21 0
6/8% car.	£20 0
8/10% car.	£19 10
Ferro-chrome—	
Max. 2% car.	£55 0
Max. 1% car.	£65 0
Max. 0.70% car.	£75 0
67/70%, carbonless	1/6½ lb.
Nickel—99% cubes or pellets	£130 0
Cobalt metal—98/99%	11/6 lb.
Aluminium—98/99%	£100
Metallic Chromium—	
96/98%	4/6 lb.
Ferro-manganese (net)—	
76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£15
Metallic manganese—	
94/96%, carbonless	2/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. .. 3d. lb.
Packing .. .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	4 7 6	4 15 0
Bundled steel & shearings	4 0 0	4 10 0
Mixed iron & steel	4 0 0	4 7 6
Heavy cast iron	4 0 0	4 5 0
Good machinery for foundries	4 10 0	4 15 0
Cleveland—		
Heavy steel	4 5 0	
Steel turnings	3 7 6	
Cast-iron borings	3 7 6	
Heavy forge	5 0 0	
Bushelled scrap	3 16 9	
Cast-iron scrap	4 10 0	
Lancashire—		
Cast-iron scrap	4 5 0	
Heavy wrought	4 5 0	
Steel turnings	3 0 0	

London — Merchants' buying prices delivered yard.

Copper (clean)	61 0 0
Brass (clean)	36 0 0
Lead (less usual draft)	24 0 0
Tea lead	20 0 0
Zinc	24 10 0
New aluminium cuttings	64 0 0
Braziery copper	55 0 0
Gun metal	45 0 0
Hollow pewter	150 0 0
Shaped black pewter	90 0 0

PIG-IRON.

N. E. Coast—	
Foundry No. 1	117/6
Foundry No. 3	115/-
Forge No. 4	100/-
Mottled	—
Hematite No. 1	111/-
Hematite M/Nos.	110/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	200/-
,, ,, roll iron	210/-
,, basic	—
Northants forge	80/-
,, foundry No. 3	87/6
,, basic	100/-
Derbyshire forge	87/6
,, foundry No. 3	95/-
,, basic	100/-
Scotland—	
Foundry No. 1	111/6
,, No. 3	106/6
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	90/-
,, foundry No. 3	95/-
Lincs. forge	95/-
,, foundry No. 3	100/-
,, basic	100/-
E.C. hematite	200/3
W.C. hematite	120/-
All d/d in the district.	
Lancashire (d/d eq. Man.) —	
Derby forge	—
,, foundry No. 3	98/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	98/6
Summerlee foundry	123/6
Glengarnock foundry	123/6
Gartsherrie foundry	123/6
Monkland foundry	123/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.
Bars (cr.)	£11 0 to 11 10 0
Angles	£10 15 to 11 15 0
Tees to 3 united ins.	11 10 0
Nut and bolt	10 10 0
Hoops	15 0 0
Marked bars (Staffs.)	13 10 0
Gas strip	£10/15 to £11
Bolts and nuts, ¾ in. × 4 in.	18 0 0
Steel—	
Ship plates	£9 10/- to 10 0 0
Boiler plates	13 0 0
Chequer plates	10 15 0
Angles	£9 0 0 to 9 15 0
Tees	£9 12 6 to 10 0 0
Channels	9 5 0
Joists	9 0 0
Rounds & squares 3 in. to 5½ in.	11 0 0
Rounds under 3 in. to ⅝ in.	10 15 0
Flats, over 5 in. wide and up	11 5 0
Flats, 5 in. to 1½ in.	10 10 0
Rails, heavy	9 10 0
Fishplates	13 10 0
Hoops	11 10 0
Black sheets, 24 g.	13 5 0
Galv. cor. sheets, 24 g.	£19 0 0 to 19 10 0
Galv. fencing wire. 8 g. plain	16 0 0
Rivets, ¾ in. dia.	13 0 0
Billets, soft	8 0 0 to 8 10 0
Billets, hard	8 10 0 to 9 0 0
Sheet bars	7 12 6 to 7 15 0
Tin bars	8 6 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3¼
Sheet	1 4
Wire	1 4
Rods	1 2¾
Tubes	1 6½
Castings	1 1½

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10¾
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0¼
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.76
No. 2 foundry, Valley	27.00
No. 2 foundry, Birm.	24.00
Basic	27.46
Bessemer	29.52
Malleable	28.27
Grey forge	28.27
Ferro-manganese 80% delivered	107.50
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	38.50
O.-h. billets	38.50
O.-h. sheet bars	39.50
Wire rods	47.50
	Cents.
Iron bars, Phila.	2.47
Steel bars	2.15
Tank plates	2.20
Beams, etc.	2.15
Skelp, grooved steel	2.10
Skelp, sheared steel	2.10
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.55
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	37/6 to 42/6
,, furnace	25/- to 30/-
Durham & North. fdy.	40/6
,, furnace	32/6
Other Districts, foundry	38/-
,, furnace	26/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C.Cokes,	20×14, box	21/6
,,	28×20, ,,	43/-
,,	20×10, ,,	31/6
,,	18¾×14, ,,	22/6
C.W.	20×14, ,,	19/9
,,	28×20, ,,	40/6
,,	20×10, ,,	28/9
,,	18¾×14, ,,	20/6
Ternes. f.o.t.	28×20, ,,	40/-

TUBES.

Up to and incl. 6 in.

Gas .. ..57½% } Tube prices
Water ..52½% } are
Steam ..47½% } now free.

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	16 10 0 to 17 5 0
Nail Rods—Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32
Blooms—
Single welded .. £10 to £11
Billets—
Single and double welded .. .. £13 to £14
Pig-iron—
Grey, white or mottled £6 10 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Feb. 14	66 5 0	inc. 7/6
,, 15	66 12 6	,, 7/6
,, 16	67 15 0	,, 22/6
,, 19	68 17 6	,, 22/6
,, 20	69 0 0	,, 2/6

Electrolytic Copper.

Feb. 14	72 15 0	No change
,, 15	73 0 0	inc. 5/–
,, 16	74 10 0	,, 30/–
,, 19	75 10 0	,, 20/–
,, 20	76 0 0	,, 10/–

Standard Tin (cash).

Feb. 14	186 7 6	dec. 7/6
,, 15	187 10 0	inc. 22/6
,, 16	191 0 0	,, 70/–
,, 19	193 0 0	,, 40/–
,, 20	191 10 0	dec. 30/–

Tin (English ingots).

Feb. 14	186 5 0	dec. 10,–
,, 15	187 10 0	inc. 25/–
,, 16	191 0 0	,, 70/–
,, 19	193 0 0	,, 40/–
,, 20	191 10 0	dec. 30/–

Zinc Sheets (English).

Feb. 14	44 0 0	No change
,, 15	44 0 0	,,
,, 16	44 0 0	,,
,, 19	44 0 0	,,
,, 20	44 0 0	,,

Spelter (ordinary).

Feb. 14	35 5 0	inc. 2/6
,, 15	35 2 6	dec. 2/6
,, 16	35 12 6	inc. 10/–
,, 19	35 15 0	,, 2/6
,, 20	36 0 0	,, 5/–

Lead (English).

Feb. 14	29 10 0	No change
,, 15	29 10 0	,,
,, 16	29 10 0	,,
,, 19	29 10 0	,,
,, 20	29 10 0	,,

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 4	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 11	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	37 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 0
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7¼	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7¼	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0¾	65 3	65 11	69 10½	75 7½	65 7¼
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	85	10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	91 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	209	3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3	90 7

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